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(54) **Curable perfluoropolyether gel composition and gel product produced by using cured perfluoropolyether gel composition**

Härtbare Perfluoropolyether-Gelzusammensetzung und mit gehärteter
Perfluoropolyether-Gelzusammensetzung hergestelltes Gelprodukt

Composition de gel perfluoropolyéther durcissable et produit de gel produit par l'utilisation de la
composition de gel perfluoropolyéther durci

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EP-A1- 1 995 278 EP-A1- 2 383 318
EP-A2- 1 033 387 EP-A2- 1 327 667**

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DescriptionTECHNICAL FIELD

[0001] This invention relates to a perfluoropolyether gel composition capable of producing a cured gel composition having improved heat resistance, solvent resistance, and chemical resistance, and in particular, a cured gel composition having an improved acid resistance. This invention also relates to a gel product produced by using the cured gel composition.

BACKGROUND ART

[0002] JP 3487744 (Patent Document 1) discloses that a cured gel product having well balanced heat resistance, chemical resistance, solvent resistance, water repellency, oil repellency, weatherability, and the like can be produced by curing a composition containing a straight chain perfluoropolyether compound having at least two alkenyl groups per molecule and including a perfluoropolyether structure in its backbone; a straight chain perfluoropolyether compound having one alkenyl group per molecule and including a perfluoropolyether structure in its backbone; an organosilicon compound having at least two hydrosilyl groups per molecule; and a hydrosilylation catalyst.

[0003] Such perfluoropolyether gel composition has sufficient performance for almost all applications. However, higher acid resistance may be required in the applications where chemical resistance is required, for example, in the applications such as a sealant for semiconductor production system, a sealant and potting agent for engine oils, and a sealant and potting agent for engine exhaust parts. Accordingly, there is a strong demand for a perfluoropolyether gel composition having excellent oil resistance and chemical resistance, and in particular, an excellent acid resistance.

[0004] Prior art documents relevant with the present invention include those as described below.

[0005] Of these, the polymer having an [aromatic ring - Si atom - vinyl group] structure at its terminal described in Japanese Patent 2990646 is known to have an excellent rapid curability due to the presence of the [Si atom - vinyl group] structure while this polymer is inferior in the acid resistance due to the presence of the binding site between the aromatic ring and the Si atom. On the other hand, polymers having no [aromatic ring - Si atom - vinyl group] structure on its terminal (for example, a polymer having an [aromatic ring - alkylene group - vinyl group] structure on its terminal or a polymer having an [amide group having an aromatic ring substituent in the side chain - alkylene group - vinyl group] structure on its terminal) have excellent acid resistance while these polymers suffered from inferior rapid curability.

Citation List**[0006]**

Patent Document 1: JP 3487744

Patent Document 2: JP 2990646

Patent Document 3: JP-A 2000-248166

SUMMARY OF THE INVENTION

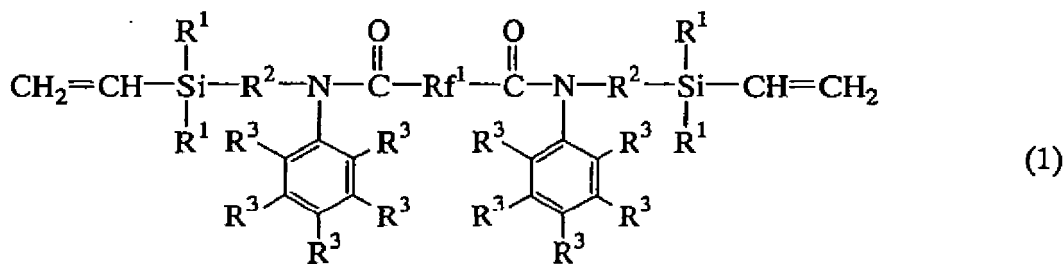
[0007] The present invention has been completed to correspond to the situation as described above, and an object of the present invention is to provide a perfluoropolyether gel composition capable of producing a cured composition having improved heat resistance, solvent resistance, chemical resistance, weatherability, releasability, water repellency, and oil repellency, and in particular, an excellent acid resistance. Another object of the present invention is to provide a gel product produced by using the cured gel composition.

[0008] The inventors of the present invention made an intensive study to obviate the defects of the conventional perfluoropolyether gel compositions as described above, and found that a curable perfluoropolyether gel composition according to claim 1 of realizing the objects as described above. The present invention has been completed on the basis of such finding.

[0009] Accordingly, the present invention provides the curable perfluoropolyether gel composition and the gel product produced by using cured perfluoropolyether gel composition as described below.

[1] A curable perfluoropolyether gel composition according to claim 1 comprising

(A) a straight chain fluorine-containing polymer having at least two alkenyl groups per molecule, represented by the following formula (1):



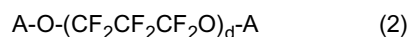
wherein R¹ is independently vinyl group or an alkyl group containing 1 to 4 carbon atoms, R² is an alkylene group containing 1 to 6 carbon atoms, R³ is independently hydrogen atom or an alkyl group containing 1 to 4 carbon atoms optionally substituted with fluorine, and Rf¹ is a divalent perfluoropolyether structure-containing group,

(B) a polyfluoromonoalkenyl compound according to formula (9) containing one alkenyl group per molecule and having a perfluoropolyether structure in its backbone,

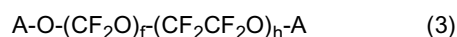
(C) an organosilicon compound containing at least two hydrogen atoms bonded to the silicon atom per molecule, and

(D) a hydrosilylation catalyst, and

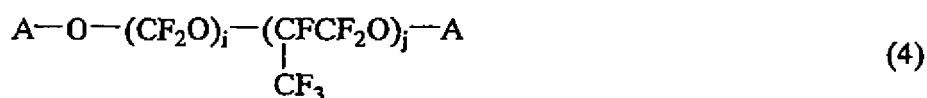
(E) at least one perfluoropolyether compound selected from the group consisting of the compounds represented by the following general formulae (2) to (4):



wherein A is a group represented by the formula: C_eF_{2e+1} - wherein e is an integer of 1 to 3, and d is an integer of 1 to 500;



wherein A is as described above, and f and h are independently an integer of 1 to 300, and



wherein A is as described above, and i and j are independently an integer of 1 to 300, wherein a penetration of a cured product of the gel composition according to JIS K2220 or ASTM D-1403 is in the range of 1 to 200.

[2] A curable perfluoropolyether gel composition according to [1] wherein an amount of a cured product of the gel composition remaining in solid state after immersing in conc. sulfuric acid (98%) at 40°C for 1,000 hours is at least 90%.

[3] A gel product containing a cured product of the curable perfluoropolyether gel composition of any one of the above [1] to [3]. [4] A gel product according to the above [3] wherein the product is adapted for use in automobiles, chemical plants, ink jet printers, semiconductor production lines, physical and chemical analysis equipment, medical equipment, aircrafts, or fuel cell production.

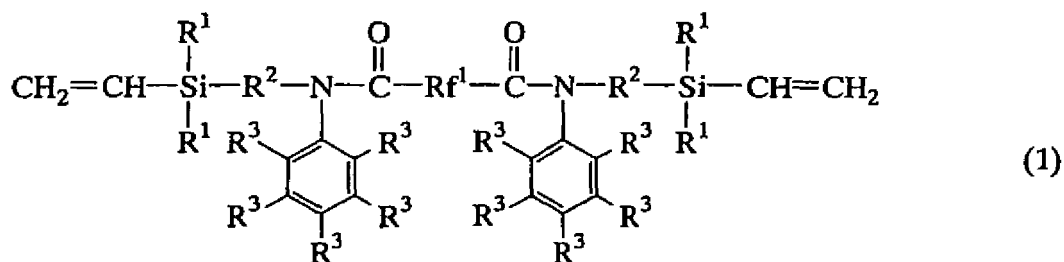
ADVANTAGEOUS EFFECTS OF THE INVENTION

[0010] The present invention provides a perfluoropolyether gel composition which can be produced into a cured product having excellent heat resistance, solvent resistance, chemical resistance, weatherability, releasability, water repellency, oil repellency, and the like as well as an improved acid resistance. The gel product produced by using the cured product of such composition is well adapted for use as a material in automobiles, chemical plants, ink jet printers, semiconductor production lines, analytical, physical, and chemical apparatus, medical instrument, aircrafts, fuel cells, and the like.

DESCRIPTION OF THE EMBODIMENTS

[0011] The curable perfluoropolyether gel composition of the present invention according to claim 1 comprises

(A) a straight chain fluorine-containing polymer having at least two alkenyl groups per molecule, represented by the following formula (1):



wherein R¹ is independently vinyl group or an alkyl group containing 1 to 4 carbon atoms, R² is an alkylene group containing 1 to 6 carbon atoms, R³ is independently hydrogen atom or an alkyl group containing 1 to 4 carbon atoms optionally substituted with fluorine, and Rf¹ is a divalent perfluoropolyether structure-containing group,

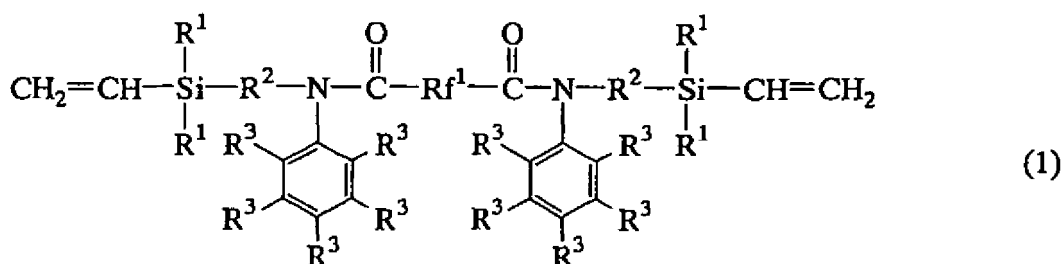
(B) a polyfluoromonoalkenyl compound according to formula (9) containing one alkenyl group per molecule and having a perfluoropolyether structure in its backbone,

(C) an organosilicon compound containing at least two hydrogen atoms bonded to the silicon atom per molecule, and

(D) a hydrosilylation catalyst, and [E] at least one perfluoropolyether compound selected from formulae (2) to (4).

Component (A)

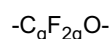
[0012] Component (A) of the present invention is a straight chain fluorine-containing polymer having at least two alkenyl groups per molecule, represented by the following formula (1):



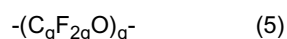
wherein R¹ is independently vinyl group or an alkyl group containing 1 to 4 carbon atoms, R² is an alkylene group containing 1 to 6 carbon atoms, R³ is independently hydrogen atom or an alkyl group containing 1 to 4 carbon atoms optionally substituted with fluorine, and Rf¹ is a divalent perfluoropolyether structure-containing group.

[0013] In the formula (1), R¹ is independently vinyl group or an alkyl group containing 1 to 4 carbon atoms. Examples of the alkyl group containing 1 to 4 carbon atoms include methyl group, ethyl group, propyl group, and butyl group, and R¹ is preferably vinyl group or methyl group. R² is an alkylene group containing 1 to 6, and preferably 3 to 6 carbon atoms. Exemplary R² include methylene group, ethylene group, propylene group (trimethylene group or methylethylene group), butylene group (tetramethylene group or methylpropylene group), and hexamethylene group, and R² is preferably ethylene group or trimethylene group. R³ is independently hydrogen atom or an alkyl group containing 1 to 4 carbon atoms optionally substituted with fluorine. Exemplary alkyl groups containing 1 to 4 carbon atoms include those as mentioned above for R¹. Rf¹ is a divalent perfluoropolyether structure-containing group.

[0014] Examples of the divalent perfluoropolyether structure-containing group include a straight chain or branched perfluoroalkylene group containing about 2 to 10, and preferably about 2 to 6 carbon atoms. The perfluoropolyether structure-containing group is the one containing a number of constitutional repeating units represented by the following formula:

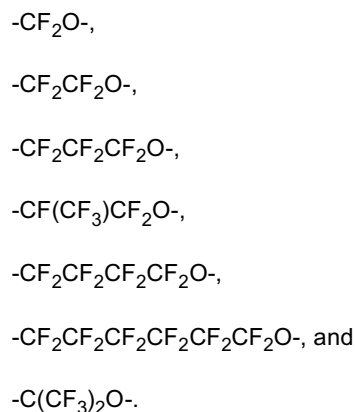


wherein g is an integer of 1 to 6, such as the one represented by the following formula (5):

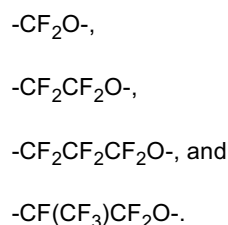


wherein g is an integer of 1 to 6, q is an integer of 20 to 600, preferably 30 to 400, and most preferably 30 to 200.

[0015] Examples of the constitutional repeating unit represented by the formula $-C_gF_{2g}O-$ include those represented by the following formulae:

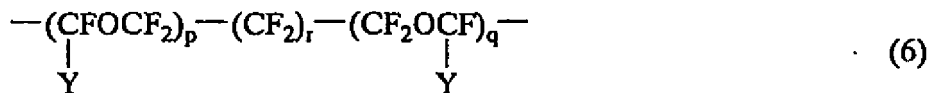


Of these, preferable units are those represented by the following formulae:

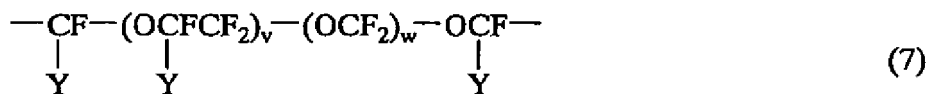


[0016] The divalent perfluoropolyether structure-containing group may comprise one type of constitutional repeating unit or a combination of two or more such constitutional repeating units.

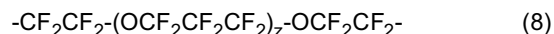
[0017] The divalent perfluoropolyether structure-containing group may preferably comprise a structure selected from the group consisting of the units represented by the following formulae (6) to (8):



wherein Y is fluorine atom or trifluoromethyl group, p, q, and r are independently an integer of $p \geq 0$, $q \geq 0$, $0 \leq p+q \leq 200$ and most preferably $2 \leq p+q \leq 150$, and $0 \leq r \leq 6$ excluding the case of $p = q = r = 0$;

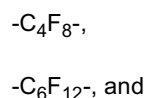


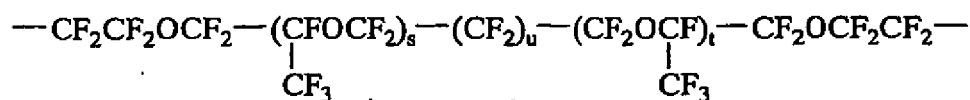
wherein Y is fluorine atom or trifluoromethyl group, and v and w are independently an integer of $1 \leq v \leq 20$ and $1 \leq w \leq 20$; and



wherein z is an integer of $1 \leq z \leq 100$.

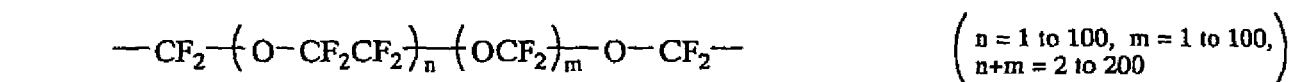
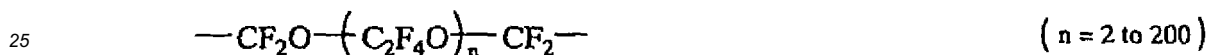
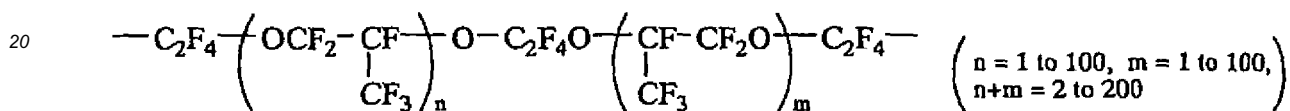
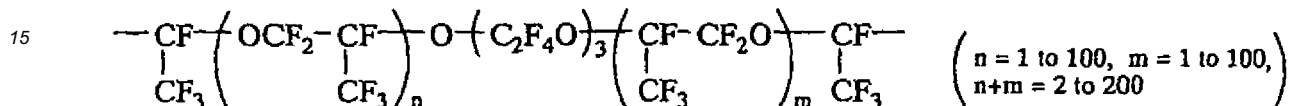
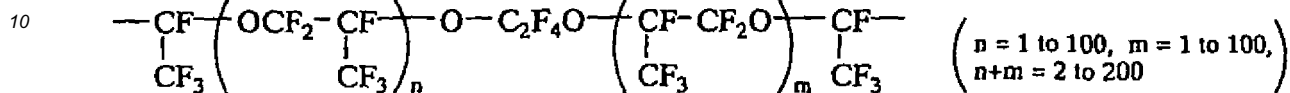
[0018] In the formula (1), examples of Rf^1 include those represented by the following formulae:



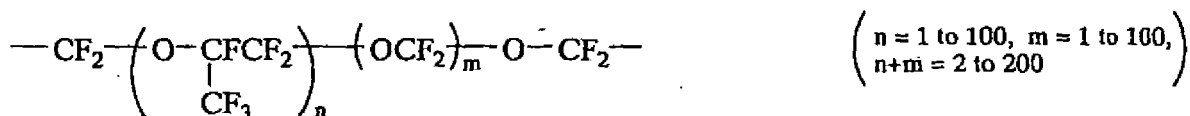


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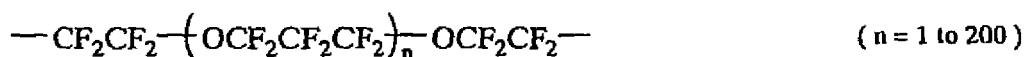
wherein s, t, and u are independently an integer of $s \geq 0$, $t \geq 0$, and $0 \leq s+t \leq 200$, and most preferably $2 \leq s+t \leq 150$, and $0 \leq u \leq 6$,



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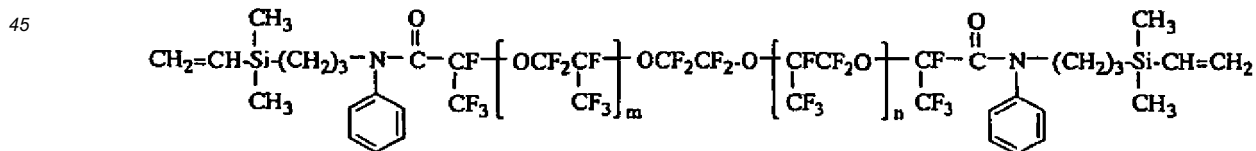


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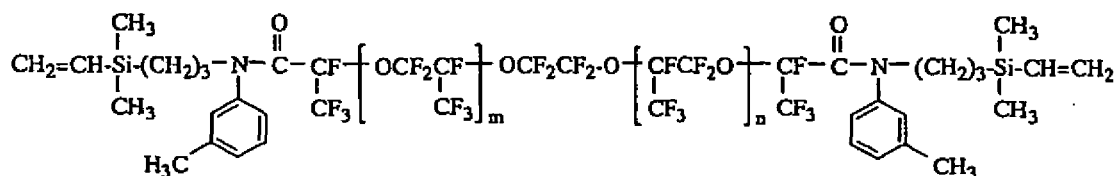


wherein m, n, and m+n are independently an integer as defined above.

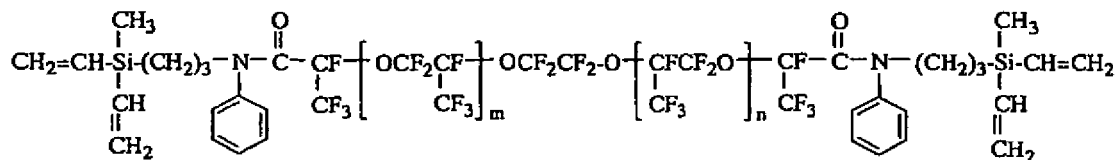
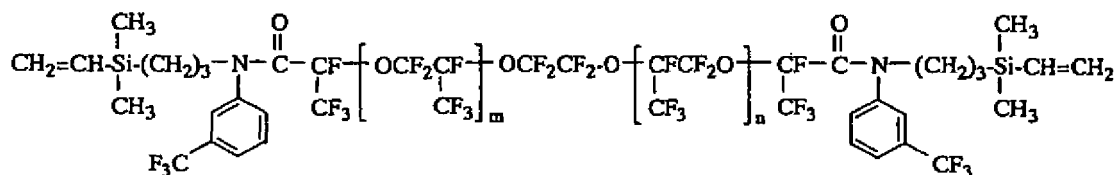
[0019] Preferable examples of the straight chain fluorine-containing polymer represented by the general formula (1) include those represented by the following formulae:



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wherein m is 1 to 100, n is 1 to 100, and m+n is 2 to 200.

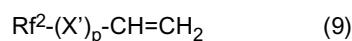
[0020] The straight chain fluorine-containing polymer of the formula (1) may preferably have a weight average molecular weight of 10,000 to 100,000, and more preferably 10,000 to 50,000 as measured by gel permeation chromatography (GPC) in terms of polystyrene. When the molecular weight is less than 10,000, the composition may exhibit an unduly high swelling by gasoline and various other solvents, and to be more specific, a member exhibiting the swelling by gasoline in excess of 6% may not fully serve a member required to have a gasoline resistance. A molecular weight in excess of 100,000 may result in high viscosity, and hence, in inferior workability.

[0021] In the present invention, the straight chain perfluoropolyether compound as described above which has been hydrosilylated with an organosilicon compound having two hydrosilyl groups (SiH groups) in the molecule by the method and conditions commonly used in the art to thereby extend the chain length may be used for the component (A) in order to impart the straight chain fluorine-containing polymer of the formula (1) with the desired weight average molecular weight adequate for the intended use.

[0022] The straight chain fluorine-containing polymer of the component (A) may comprise one such polymer or a combination of two or more such polymers.

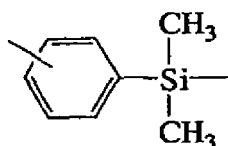
Component (B)

[0023] Component (B) is a polyfluoromonoalkenyl compound containing one alkenyl group per molecule and having a perfluoropolyether structure in its backbone. The polyfluoromonoalkenyl compound is a compound represented by the following formula (9):



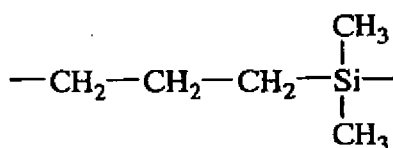
wherein

X' is $-\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{CH}_2\text{OCH}_2-$, or $-\text{CO}-\text{NR}^4-\text{Y}'$ - wherein Y' is $-\text{CH}_2-$, a group (o-, m- or p-dimethylsilylphenylene group) represented by the following structural formula (Z'):



(Z')

or a group represented by the following structural formula (Z''):

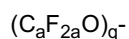


(Z'')

R⁴ is hydrogen atom, methyl group, phenyl group, or allyl group;

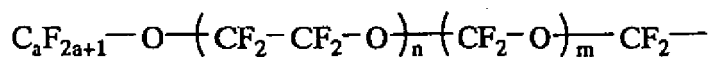
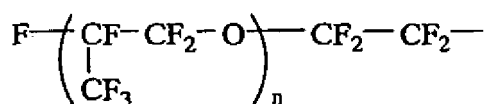
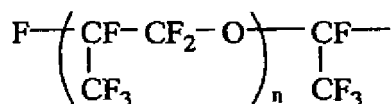
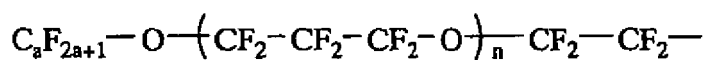
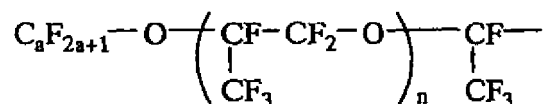
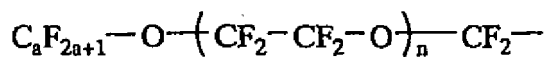
Rf² is a monovalent perfluoropolyether structure-containing group which is preferably the group represented by the

following formula:



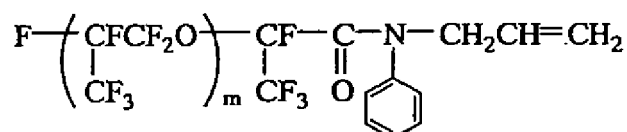
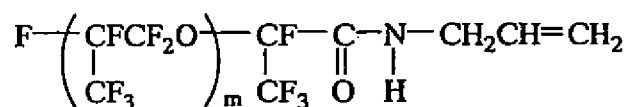
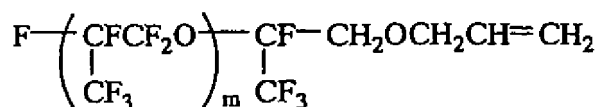
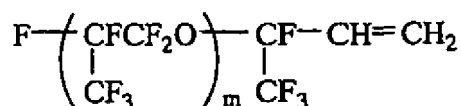
wherein a is an integer of 1 to 6, and q is an integer of 20 to 600, preferably 30 to 400, and most preferably 30 to 200; and p is 1.

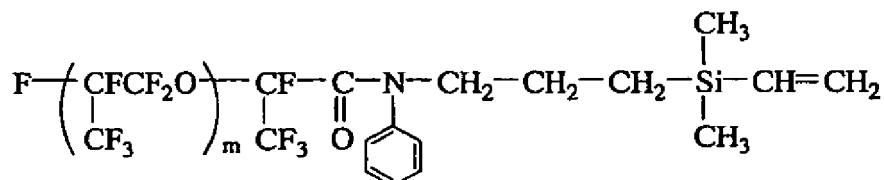
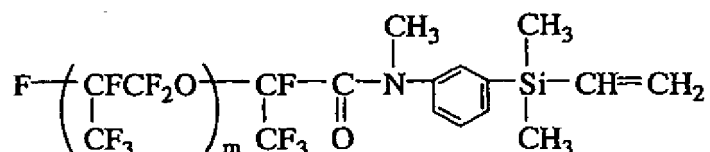
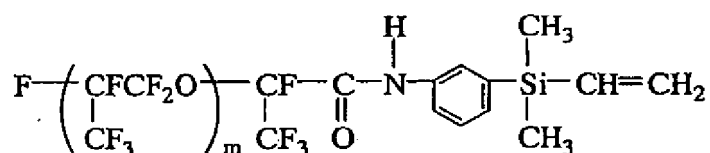
[0024] In the formula (9), Rf² may be, for example, the group represented by the following formulae:



wherein a is an integer of 1 to 8, and n is an integer of 0 ≤ n ≤ 100.

[0025] Exemplary polyfluoromonoalkenyl compounds represented by the general formula (9) include:





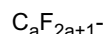
wherein $m = 1$ to 100 .

[0026] The polyfluoromonoalkenyl compound of the formula (9) is preferably incorporated in the curable perfluoropolyether gel composition of the present invention at 1 to 300 parts by weight, and more preferably 1 to 150 parts by weight per 100 parts by weight of the straight chain fluorine-containing polymer of the component (A). When the component (A) is used at less than 1 part by weight, crosslinking density after the curing will be too high to give a cured gel composition, and the resulting product may be a rubber composition. When used at a content in excess of 300 parts by weight, crosslinking density after the curing may be too low to give a cured gel composition, and the resulting product may be a liquid composition.

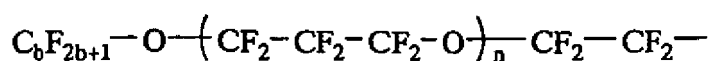
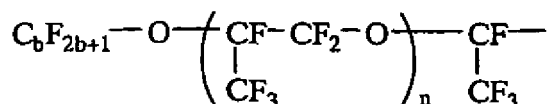
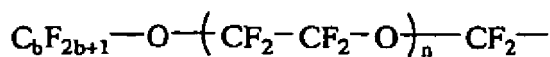
Component (C)

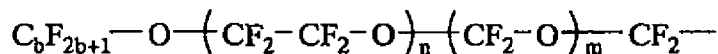
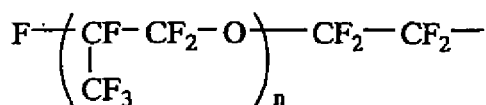
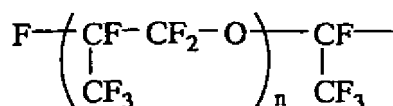
[0027] Component (C) is an organosilicon compound containing at least two hydrogen atoms bonded to the silicon atom (namely, hydrosilyl group represented by SiH) per molecule, and this organosilicon compound functions as a chain extender or a crosslinking agent for the component (A). In view of compatibility, dispersibility, and homogeneity after curing with the component (A) and/or the component (B), the preferred is use of the one containing at least one monovalent or divalent fluorine-containing organic group (for example, a monovalent fluorine-containing organic group such as a perfluoroalkyl group or a monovalent perfluoropolyether structure-containing group or a divalent fluorine-containing organic group such as a perfluoroalkylene group or a divalent perfluoropolyether structure-containing group) per molecule.

[0028] Examples of the monovalent fluorine-containing organic group include those represented by the following formulae:



wherein a is an integer of 1 to 10, and preferably 2 to 8, and



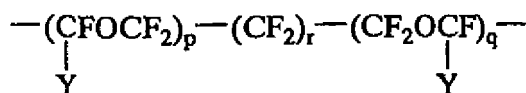


wherein b is an integer of 1 to 6, n and m are independently an integer of $0 \leq m \leq 100$, $0 \leq n \leq 100$, and $0 \leq m+n \leq 100$.

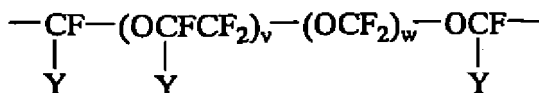
[0029] Examples of the divalent fluorine-containing organic group include those represented by the following formulae:



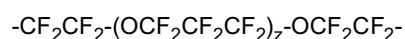
wherein g is an integer of 1 to 10, and preferably 2 to 8,



wherein Y is fluorine atom or trifluoromethyl group, p, q, and r are independently an integer of $p \geq 0$, $q \geq 0$, and $0 \leq p+q \leq 600$, and most preferably $2 \leq p+q \leq 200$ and $0 \leq r \leq 6$ with the proviso that r, p, and q are not $r = p = q = 0$,

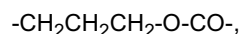
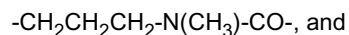
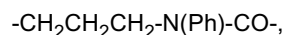
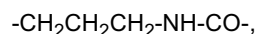
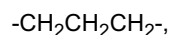
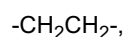


wherein Y is fluorine atom or trifluoromethyl group, v and w are independently an integer of $0 \leq v \leq 300$ and $0 \leq w \leq 300$ with the proviso that $1 \leq v+w \leq 600$, and



wherein z is an integer of $1 \leq z \leq 600$.

[0030] The monovalent or divalent fluorine-containing organic group may be bonded to the silicon atom either directly or via a divalent linking group. The divalent linking group may be an alkylene group, an arylene group a combination thereof, or any of these including oxygen atom of ether bond, amide bond, or carbonyl bond. The divalent linking group is preferably the one containing 2 to 12 carbon atoms, and examples include the groups represented by the following formulae:

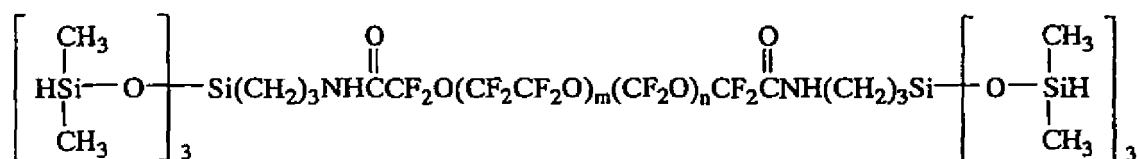
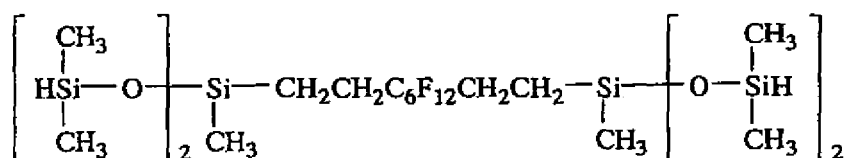
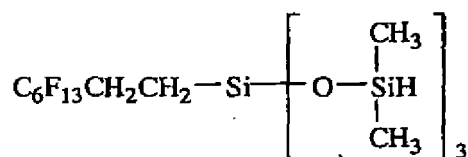


wherein Ph is phenyl group.

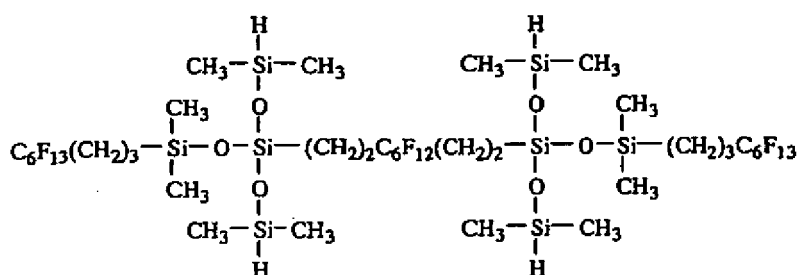
[0031] Examples of the monovalent organic group bonded to the silicon atom in the organosilicon compound of the component (C) other than the monovalent or divalent fluorine-containing organic group include alkyl groups such as methyl group, ethyl group, propyl group, butyl group, hexyl group, cyclohexyl group, octyl group, and decyl group, aryl groups such as phenyl group, tolyl group, and naphthyl group, aralkyl groups such as benzyl group, phenylethyl group, optionally substituted hydrocarbon groups containing 1 to 20 carbon atoms having some of the hydrogen atoms substituted with chlorine atom, cyano group, or the like such as chloromethyl group, chloropropyl group, and cyanoethyl group.

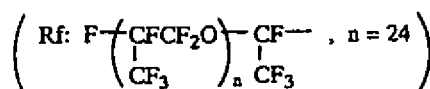
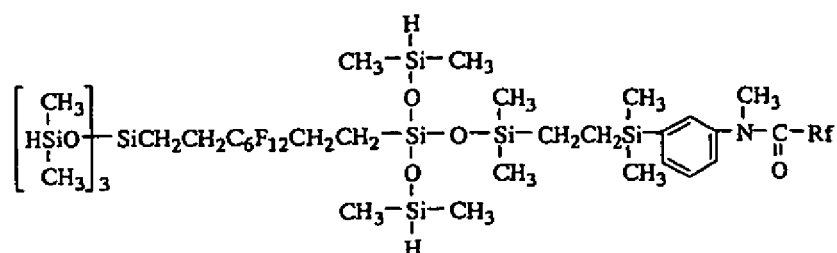
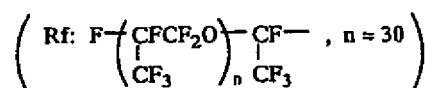
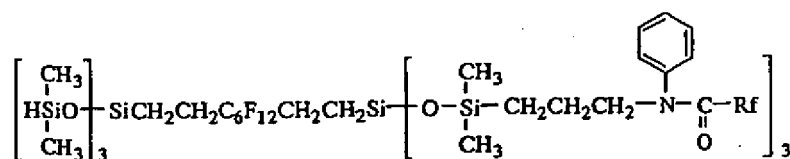
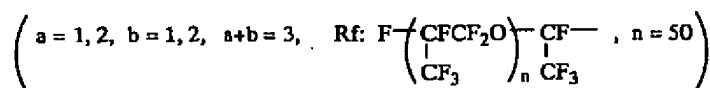
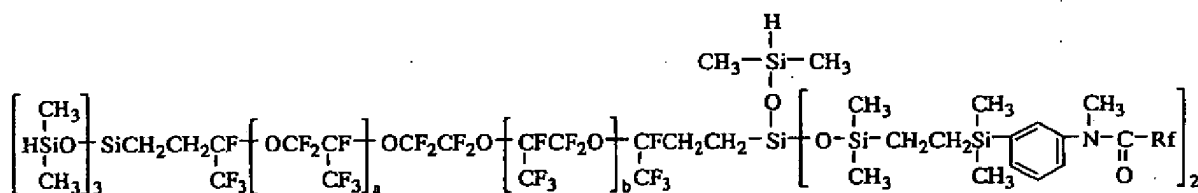
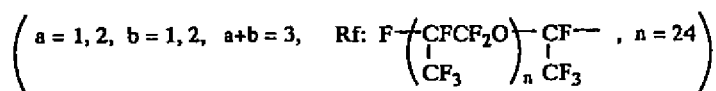
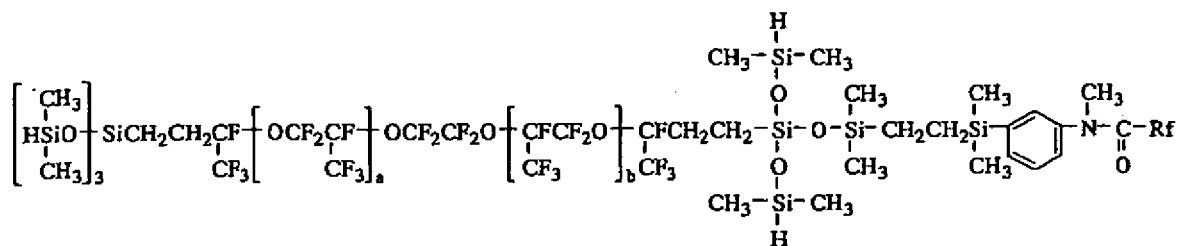
[0032] The organosilicon compound of the component (C) may be a straight chain, branched, or cyclic organosilicon compound, and the fluorine-containing organosilicon compound may typically contain 2 to about 60 carbon atoms, and preferably 3 to about 30 carbon atoms in the compound although the number of silicon atoms is not particularly limited.

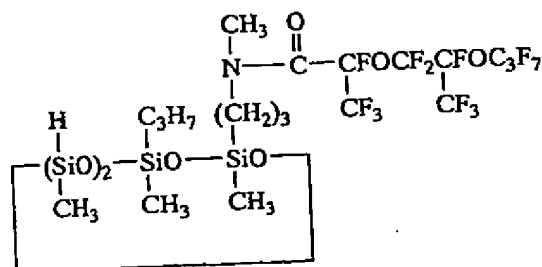
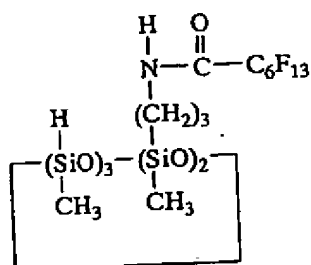
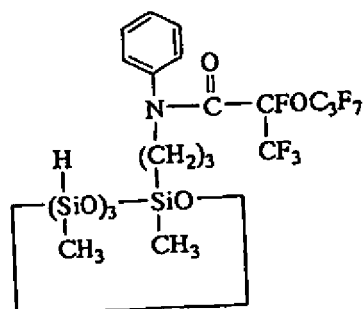
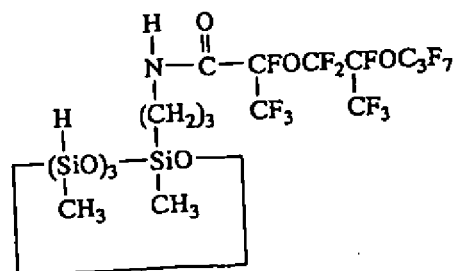
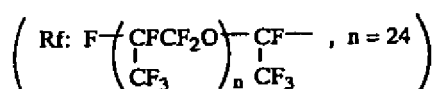
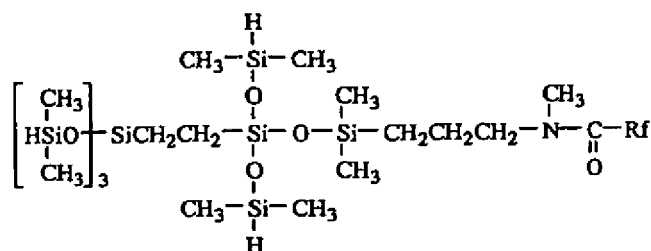
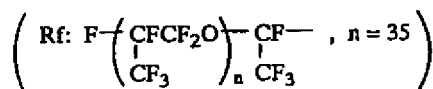
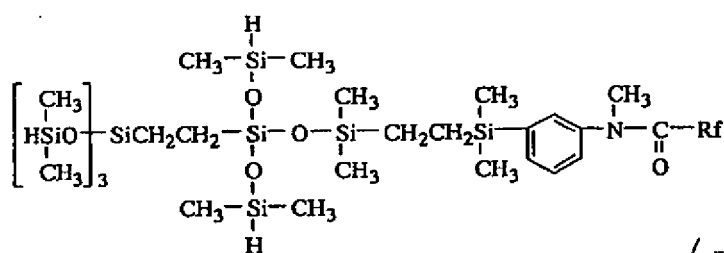
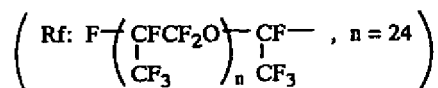
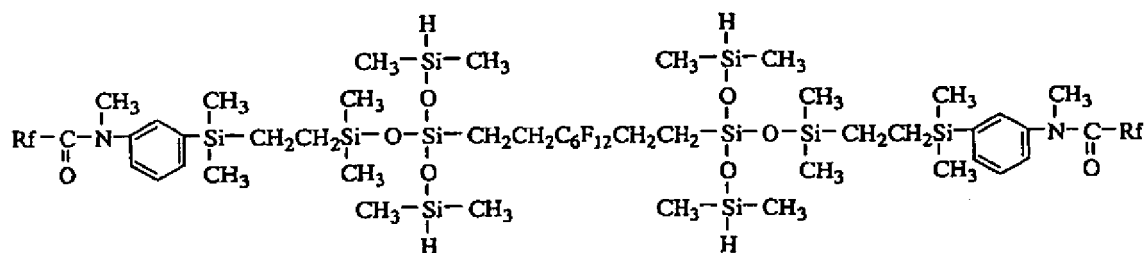
[0033] Examples of such organosilicon compound include the organosilicon compounds having a siloxane structure and/or a silalkylene structure represented by the following formulae wherein a, b, m, n, and m+n are independently an integer as defined below each formula. These compounds may be used alone or in combination of two or more.

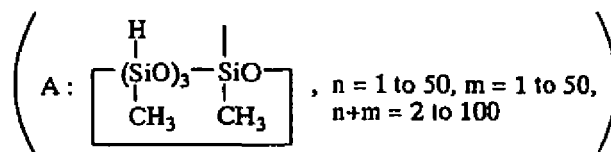
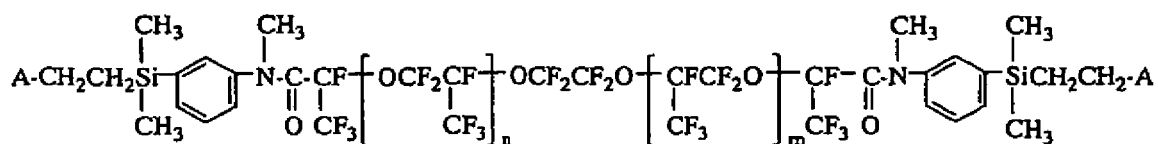
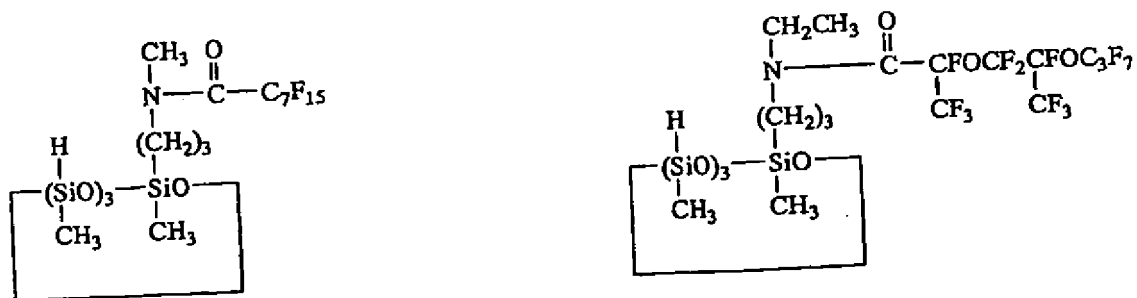
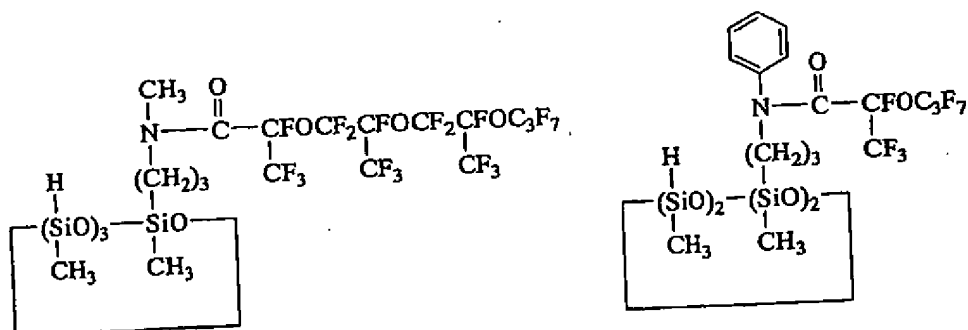
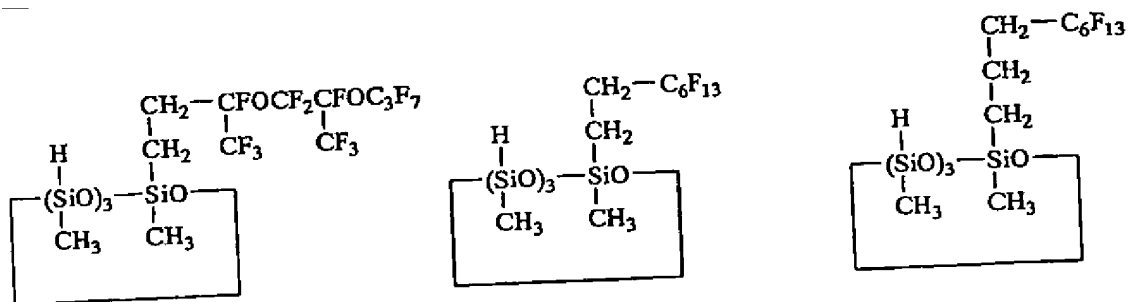


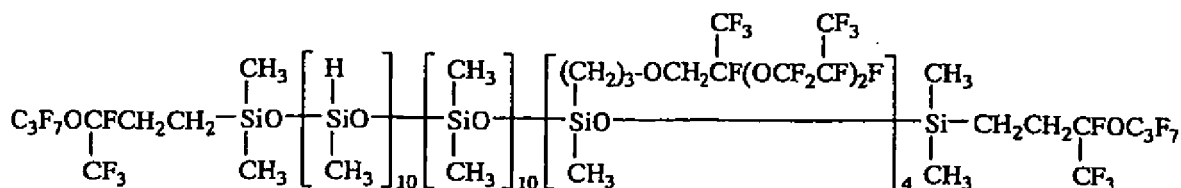
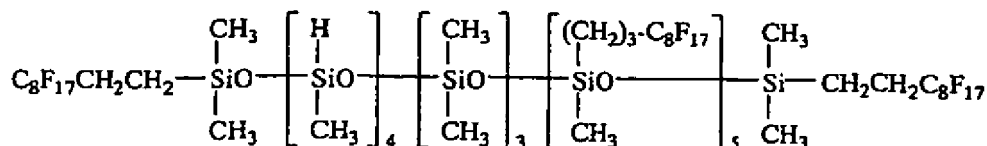
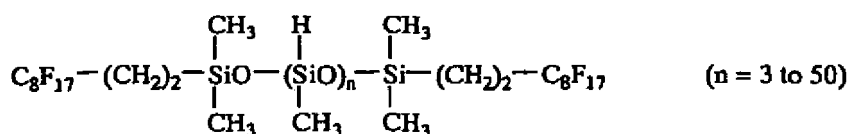
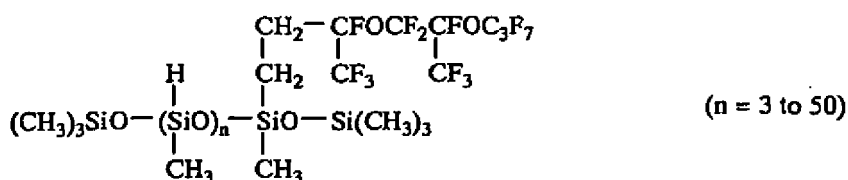
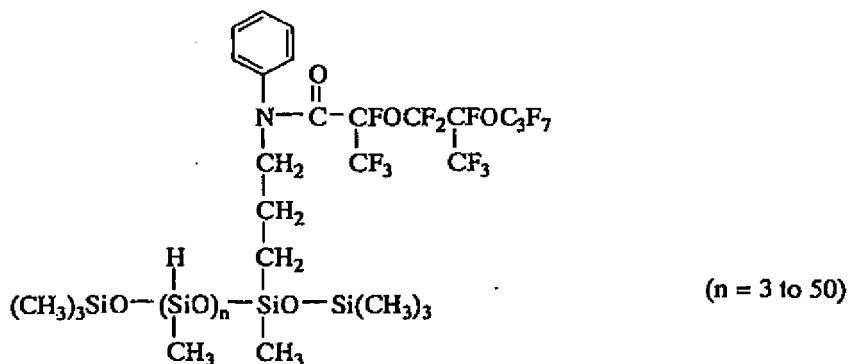
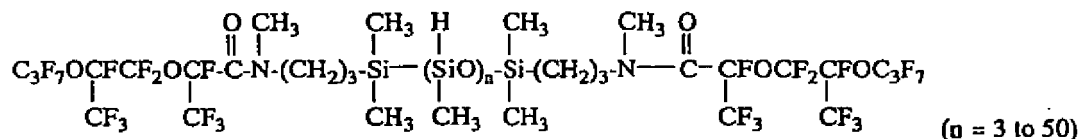
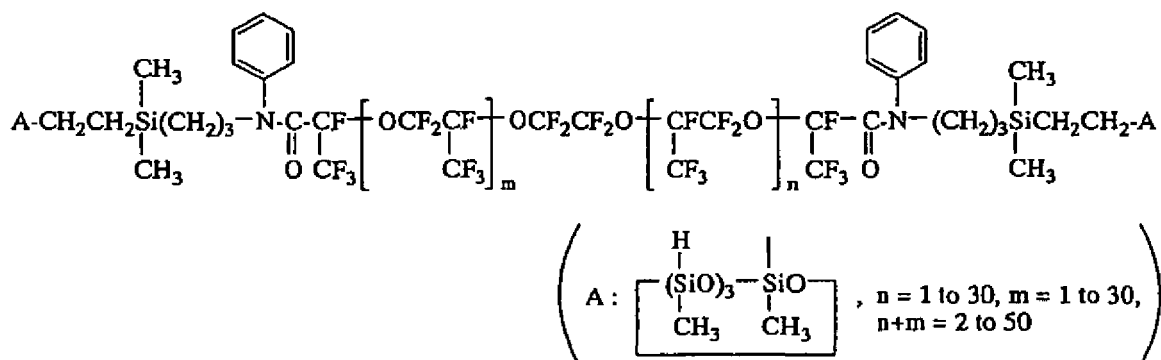
(n is 1 to 100, and preferably 1 to 50, m is 1 to 100, and preferably 1 to 50, and n+m is 2 to 200, and preferably 2 to 100).

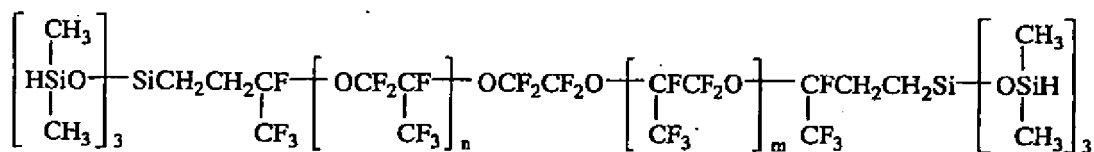
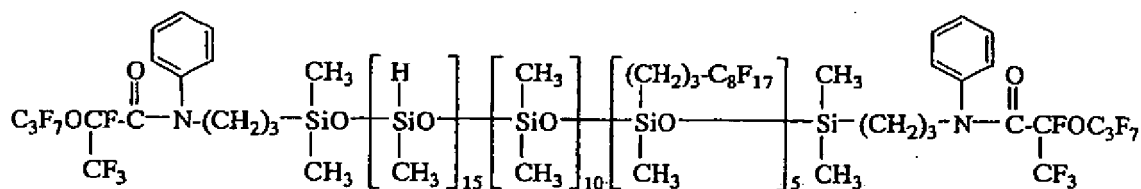
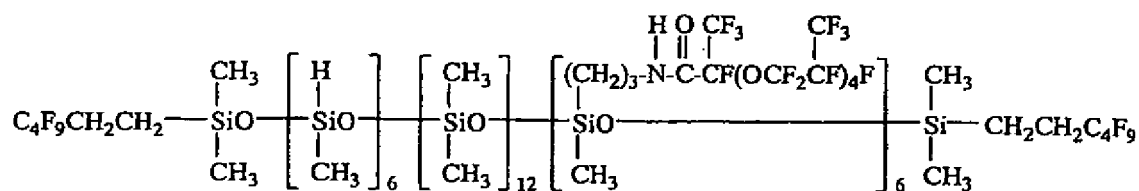




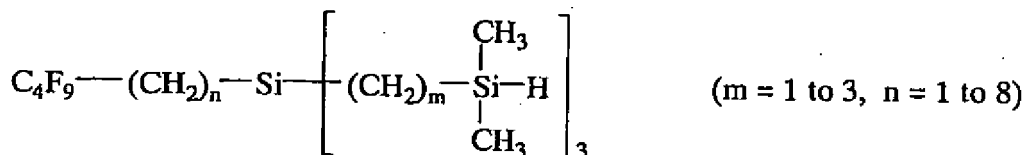
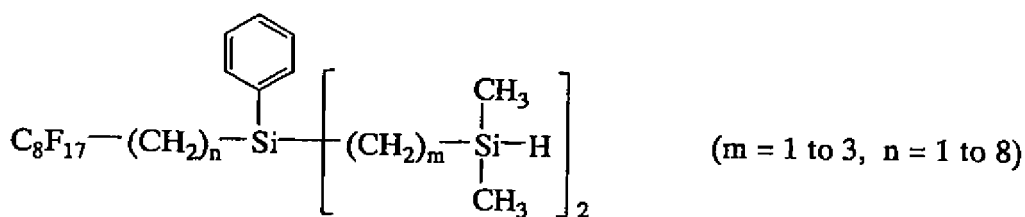
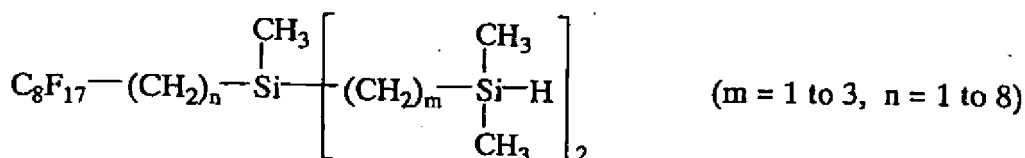
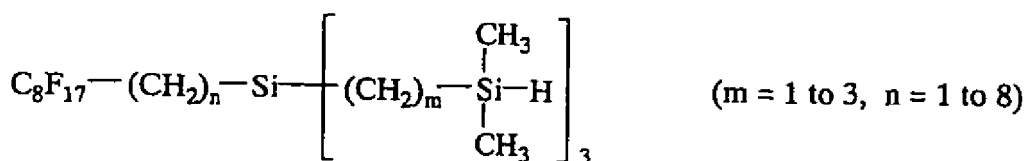


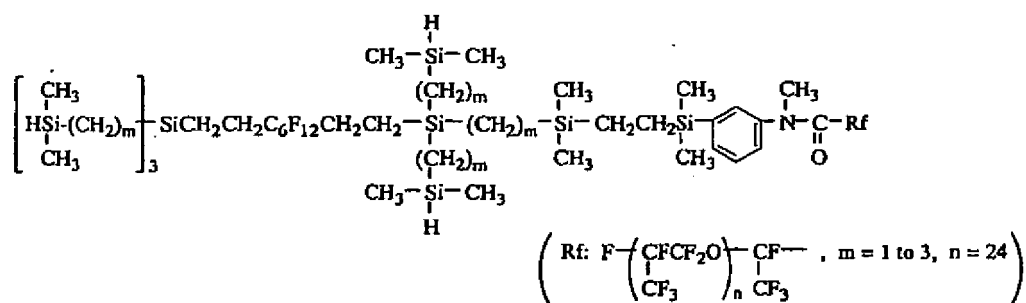
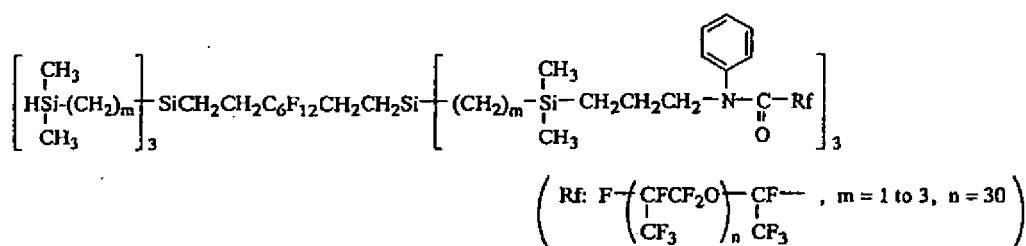
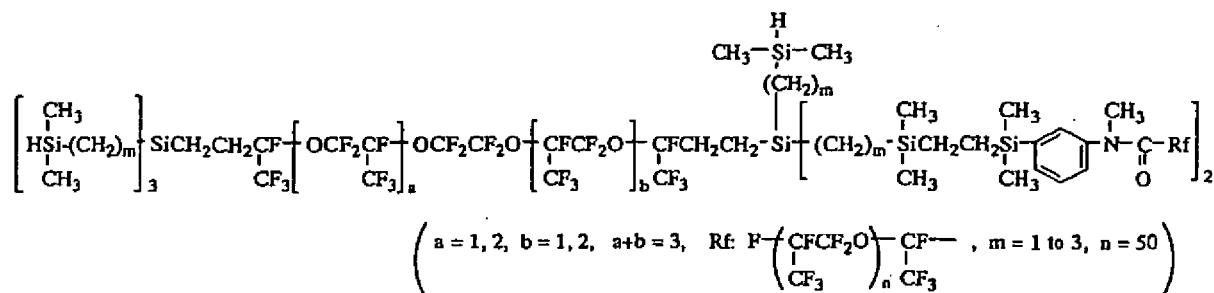
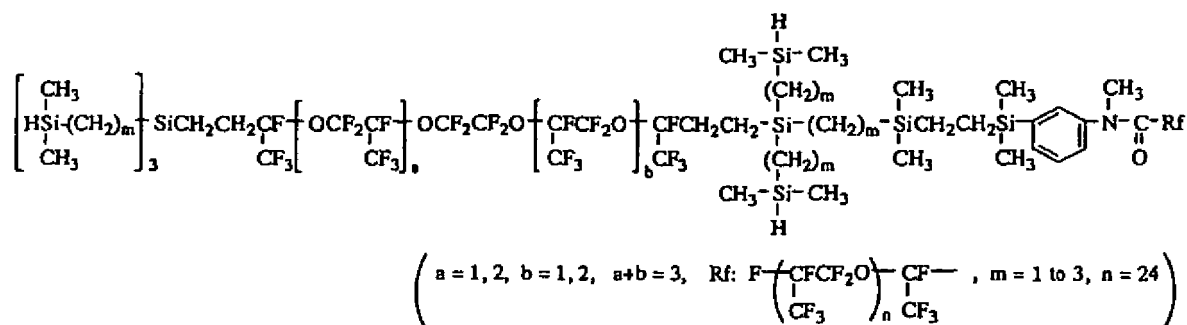
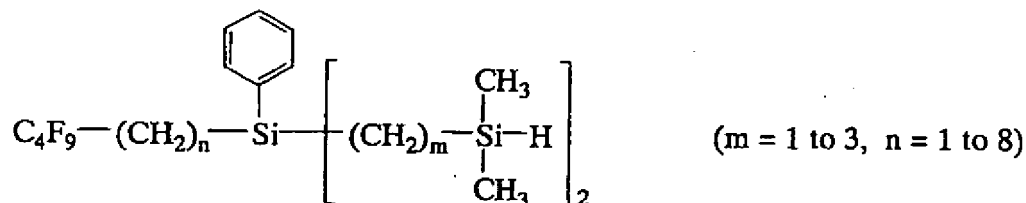
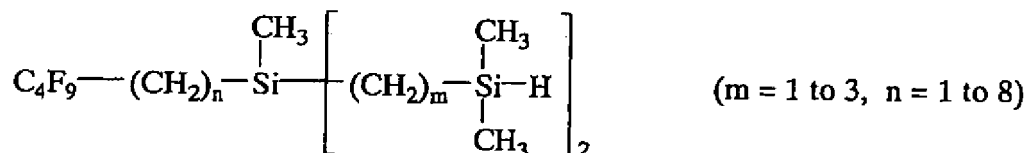


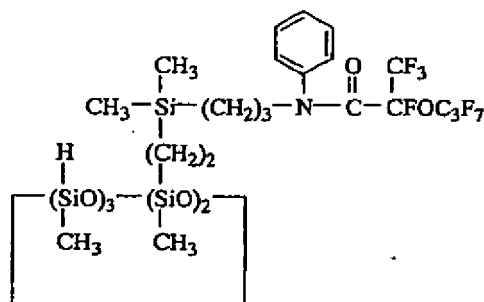
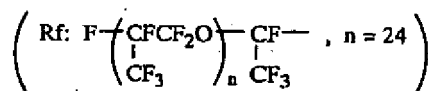
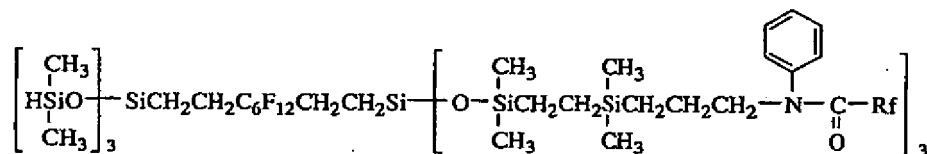
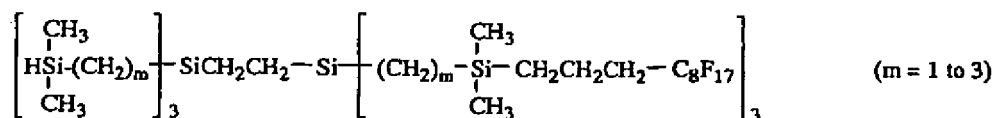
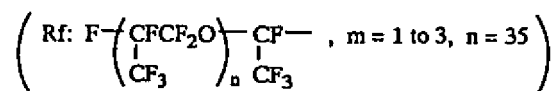
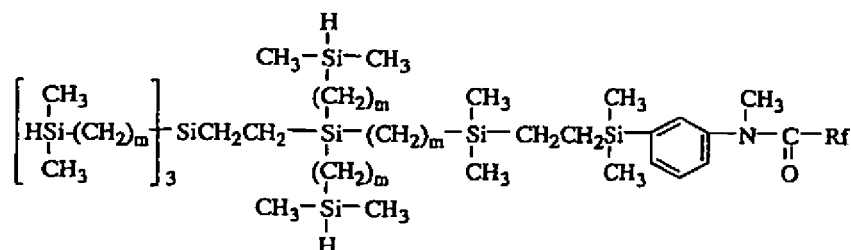
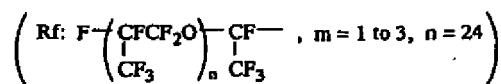
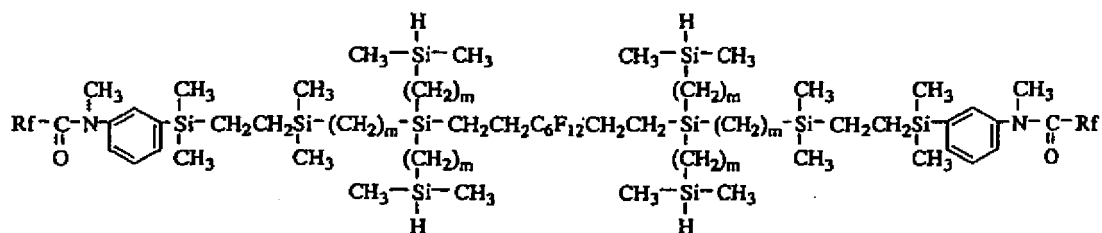




(n = 1 to 50, m = 1 to 50, n+m = 2 to 51)







[0034] Of the compounds as mentioned above for the component (C), the non-limiting preferable organosilicon compounds are those described in JP 2990646 (Patent Document 2) and JP-A 2000-248166 (Patent Document 3).

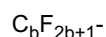
[0035] Also preferred for the organosilicon compound of the organosilicon compound component (C) are those represented by the following general formula (10):



wherein Rf³ is a monovalent perfluoroalkyl group or a monovalent perfluoropolyether structure-containing group, R³ is a monovalent hydrocarbon group containing 1 to 20 carbon atoms, R⁴ is a divalent hydrocarbon group containing 1 to 20, preferably 2 to 20 carbon atoms optionally containing ether bond, amide bond, carbonyl bond, or ester bond, k is an integer of at least 2, l is an integer of 1 to 6, and k+l is 3 to 10.

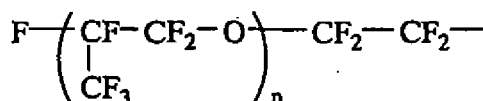
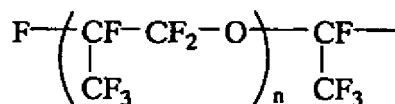
[0036] The monovalent perfluoroalkyl group and the monovalent perfluoropolyether structure-containing group Rf³ in the formula (10) include those represented by the following general formulae.

[0037] Monovalent perfluoroalkyl group:



wherein b is an integer of 1 to 20, and preferably 2 to 10.

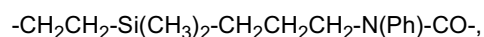
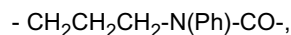
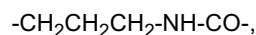
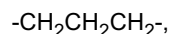
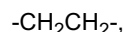
[0038] Monovalent perfluoropolyether structure-containing group:

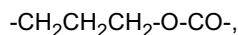
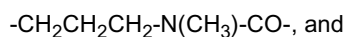
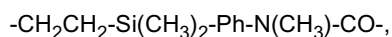


wherein n is an integer of 2 to 200, and preferably 2 to 100.

[0039] In the formula (10), R³ is preferably a monovalent hydrocarbon group containing 1 to 20 carbon atoms, and more preferably 1 to 12 carbon atoms. Exemplary such groups include alkyl groups such as methyl group, ethyl group, propyl group, isopropyl group, butyl group, isobutyl group, tert-butyl group, pentyl group, hexyl group, octyl group, and decyl group, cycloalkyl groups such as cyclopentyl group, cyclohexyl group, and cycloheptyl group, alkenyl groups such as vinyl group, allyl group, propenyl group, isopropenyl group, butenyl group, and hexenyl group, aryl groups such as phenyl group, tolyl group, xylyl group, and naphthyl group, and aralkyl groups such as benzyl group, phenylethyl group, and phenylpropyl group, and of these, the preferred are those not having an aliphatic unsaturated bond.

[0040] R⁴ is a divalent hydrocarbon group containing 1 to 20 carbon atoms which may be a divalent linking group optionally containing ether bond, amide bond, carbonyl bond, silyl group, or ester bond. Exemplary such linking groups include alkylene groups, arylene groups, combinations of such groups, or those further containing one or more of a ether bond oxygen atom (-O-), amide bond (-NRCO-), carbonyl bond (-CO-), and ester bond (-COO-). The preferred are those containing 2 to 12 carbon atoms. R in -NRCO- group is hydrogen atom, an alkyl group containing 1 to 4 carbon atoms, or phenyl group. Examples of R⁴ include those represented by the following formulae:





wherein Ph represents phenyl group.

[0041] The component (C) may be incorporated at an amount effective for curing the component (A) and the component (B). More specifically, the component (C) may be incorporated at an amount such that molar ratio of the hydrosilyl group (SiH group) in the component (C) in relation to 1 mole of the alkenyl group of the components (A) and (B) in the present composition is 0.2 to 2, and more preferably 0.5 to 1.5. When the content of the hydrosilyl group (SiH group) is too low, the crosslinking will be insufficient and the cured product may not be produced. Incorporation of too much component (C) is associated with the risk of foaming.

Component (D)

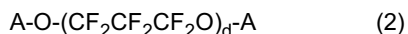
[0042] Component (D) of the present invention is a hydrosilylation catalyst which promotes addition of alkenyl groups in the component (A) and the component (B) with the hydrosilyl group in the component (C). A hydrosilylation catalyst is generally a compound of a noble metal which is expensive, and accordingly, use of platinum or a platinum compound for the hydrosilylation catalyst is preferable in view of the relatively high availability.

[0043] Examples of the platinum compound include chloroplatinic acid, a complex of chloroplatinic acid with an olefin such as ethylene, a complex of chloroplatinic acid with an alcohol or vinyl siloxane, and metal platinum loaded with silica, alumina, or carbon. Examples of the platinum group metallic compound other than the platinum compound include rhodium, ruthenium, iridium, and palladium compounds such as $\text{RhCl}(\text{PPh}_3)_3$, $\text{RhCl}(\text{CO})(\text{PPh}_3)_2$, $\text{Ru}_3(\text{CO})_{12}$, $\text{IrCl}(\text{CO})(\text{PPh}_3)_2$, and $\text{Pd}(\text{PPh}_3)_4$ wherein Ph is phenyl group.

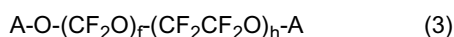
[0044] Content of the hydrosilylation catalyst is not particularly limited, and the hydrosilylation catalyst may be used at a catalytic amount. The hydrosilylation catalyst, however, may preferably be incorporated typically at 0.1 to 100 ppm in terms of the platinum group in relation to 100 parts by weight of total amount of the components (A), (B), (C), and (E).

Component (E)

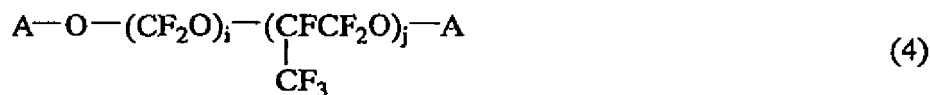
[0045] The component (E) of the present invention is at least one perfluoropolyether compound selected from the group consisting of the compounds represented by the following general formulae (2) to (4):



wherein A is a group represented by the formula: $\text{C}_e\text{F}_{2e+1}-$ wherein e is an integer of 1 to 3, and d is an integer of 1 to 500,



wherein A is as described above, and f and h are independently an integer of 1 to 300, and



wherein A is as described above, and i and j are independently an integer of 1 to 300.

[0046] Addition of this component enables production of a composition having improved chemical resistance, solvent resistance, and low-temperature properties with no adverse effects on the physical properties. In particular, when the component (E) is incorporated in a perfluoropolyether gel composition, the composition will have excellent low-temperature properties such as reduced glass transition temperature.

[0047] The component (E) is preferably used at 0.1 to 100 parts by weight, and most preferably at 0.5 to 50 parts by weight in relation to 100 parts by weight of the total of components (A) and (B). When used at an amount in excess of 150 parts by weight, bleeding may occur from the cured gel composition after prolonged period. The component (E) may comprise either a single compound or a combination of two or more compounds.

Other components

[0048] In the present composition, various known additives may be added in addition to the components (A) to (E) as described above, and such additives may be added at an amount not adversely affecting the merits of the present invention. Exemplary additive include regulators for the hydrosilylation such as acetylene alcohols such as 1-ethynyl-1-hydroxycyclohexane, 3-methyl-1-butyn-3-ol, 3,5-dimethyl-1-hexyn-3-ol, 3-methyl-1-penten-3-ol, and phenylbutynol, 3-methyl-3-penten-1-in, and 3,5-dimethyl-3-hexen-1-in, as well as polymethylvinylsiloxane cyclic compound, and organophosphorus compound. Reactivity in the curing as well as storage stability will be maintained at an adequate level by the addition of such additives.

[0049] Another example of the additive is an inorganic filler. Exemplary inorganic fillers include powder of metal oxides such as iron oxide, zinc oxide, titanium oxide, calcium carbonate, magnesium carbonate, zinc carbonate, carbon black, fumed silica, wet silica, pulverized silica, diatomaceous earth, and alumina. Addition of such filler enables adjustment of hardness and mechanical strength of the cured product obtained by using the present composition. Other additives include ion-exchange resins such as hydrotalcite, hollow inorganic fillers, rubber spherical fillers.

[0050] These optional components may be added at any amount as long as the addition does not adversely affect the merits of the present invention.

Cured product

[0051] The perfluoropolyether gel composition of the present invention can be cured and produced into a cured gel product (the so called "perfluoropolyether gel") which has excellent heat resistance, chemical resistance, solvent resistance, water repellency, oil repellency, weatherability, and the like, and in particular, excellent acid resistance. This gel product may be used in a variety of applications.

[0052] The cured product of the curable perfluoropolyether gel composition of the present invention can be formed by curing a composition containing 100 parts by weight of the component (A); 1 to 300 parts by weight of the component (B) in relation to 100 parts by weight of the component (A); component (C) at an amount such that the hydrosilyl group (SiH group) in the component (C) is 0.2 to 2.0 moles in relation to 1 mole of entire alkenyl group in the components (A) and (B); and component (D) at an amount of 0.1 to 100 ppm in terms of platinum in relation to the total amount of the components (A), (B), (C), and (E). In addition, the component (E) is added at an amount of 0.1 to 150 parts by weight of in relation to 100 parts by weight of the total of the components (A) and (B) for the purpose of, for example, reducing glass transition temperature.

[0053] The curing of the gel composition can be carried out by pouring the composition as described above in an adequate mold. More specifically, the composition may be coated on an adequate substrate and thereafter cured. The curing may also be accomplished by other known methods such as lamination. The curing is typically effected by heating to a temperature of 60 to 150°C for about 30 to 180 minutes.

[0054] The thus obtained cured product of the gel composition can be used as a gel material having a penetration of 1 to 200 as measured by the consistency test using a 1/4 cone according to JIS K2220 (or ASTM D-1403) and a glass transition temperature of up to -50°C.

[0055] The gel product produced by using the cured gel composition of the present invention is well adapted for use as a member in automobiles, chemical plants, ink jet printers, semiconductor production lines, analytical, physical, and chemical apparatus, medical instrument, aircrafts, fuel cells, and the like.

[0056] To be more specific, the gel product containing the cure product of the composition of the present invention is well adapted for use as a material for automobile parts, chemical plant parts, ink jet printer parts, parts in semiconductor production lines, parts in analytical, physical, and chemical apparatus, parts in medical instruments, moisture-proof coating agent for electro-electronic equipment, potting agent for sensors, sealants for fuel cells, and the like.

[0057] With regard to the use the composition of the present invention for a coating agent for electro-electronic equipment or potting agent for sensors, the preferred are use of the composition for gas pressure sensor, liquid pressure sensor, temperature sensor, humidity sensor, rotation sensor, G sensor, timing sensor, air flow meter, electronic circuit, semiconductor module, various control units, and the like.

[0058] When the cured product of the composition of the present invention is employed as a potting agent, coating agent, or the like, addition of a primer is useful for improving adhesion and bonding with the substrate. The primer is capable of preventing invasion of chemicals and solvents from the interface with the substrate, and therefore, improving the acid resistance, chemical resistance, and solvent resistance of the entire part.

[0059] Preferable primers include silane primers primarily comprising a silane coupling agent, primers primarily comprising an organohydrogen polysiloxane, primers primarily comprising a synthetic rubber, primers primarily comprising an acrylic resin, primers primarily comprising a urethane resin, and primers primarily comprising an epoxy resin.

[0060] In addition, the cured product of the composition of the present invention is preferably the one whose residual solid after immersing in conc. sulfuric acid (98%) under the conditions of 40°C and 1,000 hours is at least 90%. When

the residual solid is less than 90%, leakage from the sealed part as well as corrosion of the protected substrate or electro-electronic part may occur to detract from long term reliability. The acid resistance effect as demonstrated by the residual solid of at least 90% is typically realized by using the fluorine-containing polymer (A) having the particular molecular structure represented by the formula (1) in combination with the components (B) to (D), and with the component (E) for the base polymer of the gel composition.

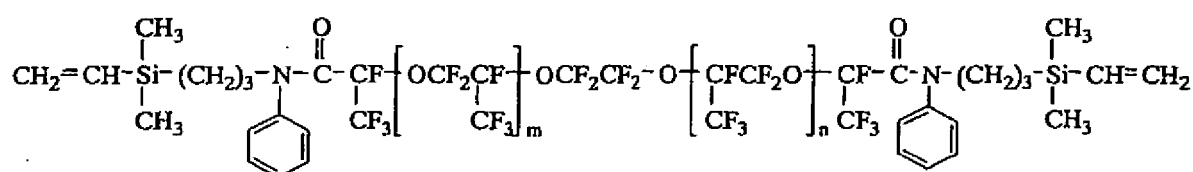
EXAMPLES

[0061] Next, the present invention is described in further detail by referring to Examples and Comparative Example, which by no means limit scope of the present invention.

Examples 1 and 2 and Comparative Example 1

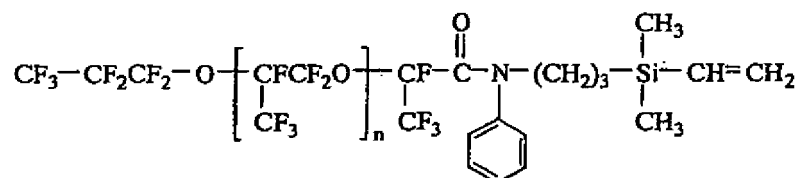
[0062] Perfluoropolyether gel compositions shown in Table 1 were prepared by using the following materials.

Polymer A:



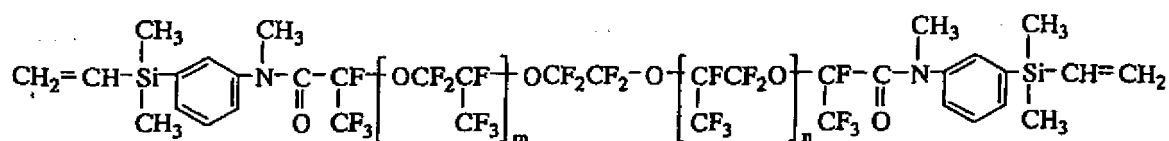
wherein average of $m+n$ is 95.

Polymer B:



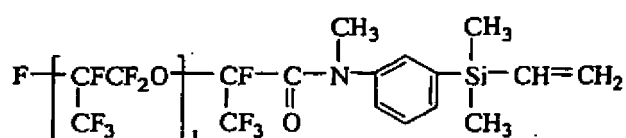
wherein average of n is 23.

Polymer C:



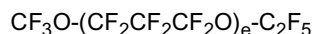
wherein average of $m+n$ is 97.

Polymer D:



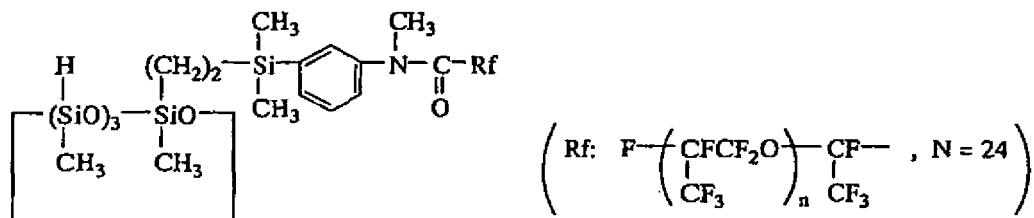
wherein L is 24.

Polymer E:



wherein e is 27.

Hydrogensiloxane:



Curing catalyst:

A solution in toluene of platinum - divinyl tetramethyl disiloxane complex (platinum content, 0.5%).

Curing regulator:

A 50% toluene solution of ethynylcyclohexanol.

[0063] Each of the thus prepared gel composition was cured under the conditions of 150°C and 1 hour, and hardness (penetration) was measured by the procedure according to JIS K2220. Acid resistance test was also conducted by the procedure as described above. The results are shown in Table 1.

Acid resistance test (weight change)

[0064] A glass container of 32 mm (diameter) × 15 mm was filled with 20 g of the composition of Examples and Comparative Examples, and the composition was cured under the conditions of 150°C and 1 hour to prepare a sample. The sample was immersed in 98% conc. sulfuric acid at 40°C for 1,000 hours, and weight change before and after the immersion was evaluated.

Acid resistance test (change in physical properties)

[0065] A glass container of 32 mm (diameter) × 15 mm was filled with 20 g of the composition of Examples and Comparative Examples, and the composition was cured under the conditions of 150°C and 1 hour to prepare a sample. The sample was immersed in 98% conc. sulfuric acid at 40°C for 1,000 hours, and penetration before and after the immersion was evaluated.

Acid resistance test (appearance)

[0066] A glass container of 32 mm (diameter) × 15 mm was filled with 20 g of the composition of Examples and Comparative Examples, and the composition was cured under the conditions of 150°C and 1 hour to prepare a sample. The sample was immersed in 98% conc. sulfuric acid at 40°C for 1,000 hours, and appearance after the immersion was evaluated by the following criteria:

- : no change
- Δ: small change (partial dissolution)
- ×: large change (total dissolution)

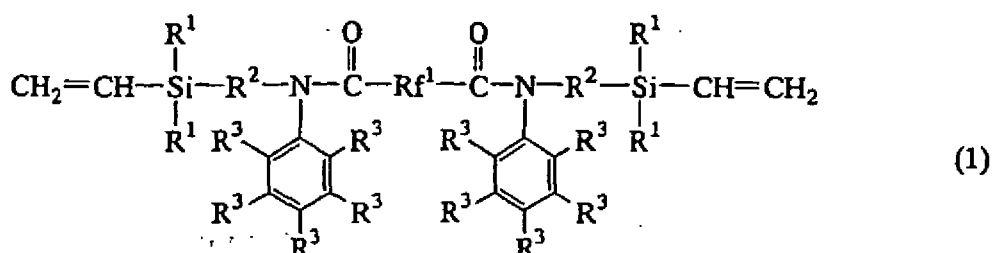
Table 1

		Example 1	Example 2	Comparative Example 1
Components (part by weight)	Polymer A	73	56	
	Polymer B	27	19	
	Polymer C			71
	Polymer D			29
	Polymer E		25	
	Curing catalyst	0.12	0.12	0.12
	Curing regulator	0.12	0.12	0.12
	Hydrogensiloxane	25.4	18.7	25.0
Penetration (at 150°C, 1 hour after the heating)		71	69	67
Acid resistance test (40°C, 1,000 hours)	Weight change	0 %	0 %	-59 %
	Penetration	70	68	Not measurable
	Outer appearance	○	○	△

Claims

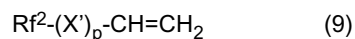
1. A curable perfluoropolyether gel composition comprising

(A) a straight chain fluorine-containing polymer having at least two alkenyl groups per molecule, represented by the following formula (1):



wherein R¹ is independently vinyl group or an alkyl group containing 1 to 4 carbon atoms, R² is an alkylene group containing 1 to 6 carbon atoms, R³ is independently hydrogen atom or an alkyl group containing 1 to 4 carbon atoms optionally substituted with fluorine, and Rf¹ is a divalent perfluoropolyether structure-containing group,

(B) a polyfluoromonoalkenyl compound containing one alkenyl group per molecule and having a perfluoropolyether structure in its backbone, and represented by the following formula (9):

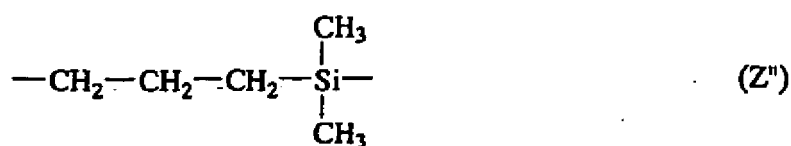


wherein

X' is -CH₂-, -OCH₂-, -CH₂OCH₂-, or -CO-NR⁴-Y'- wherein Y' is CH₂-, a group (o-, m- or p-dimethylsilylphenylene group) represented by the following structural formula (Z'):

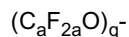


or a group represented by the following structural formula (Z''):



R⁴ is hydrogen atom, methyl group, phenyl group, or allyl group;

Rf² is a monovalent perfluoropolyether structure-containing group which is the group represented by the following formula:

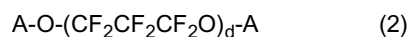


wherein a is an integer of 1 to 6, and q is an integer of 20 to 600, and p is 1,

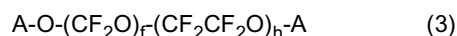
(C) an organosilicon compound containing at least two hydrogen atoms bonded to the silicon atom per molecule,

(D) a hydrosilylation catalyst,

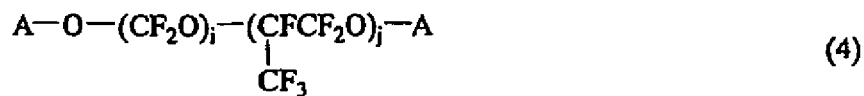
(E) at least one perfluoropolyether compound selected from the group consisting of the compounds represented by the following-general formulae (2) to (4):



wherein A is a group represented by the formula: C_eF_{2e+1}- wherein e is an integer of 1 to 3, and d is an integer of 1 to 500;



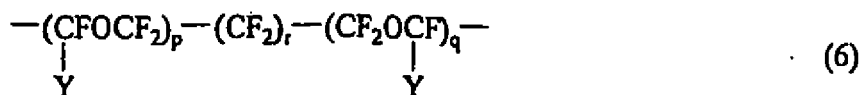
wherein A is as described above, and f and h are independently an integer of 1 to 300, and



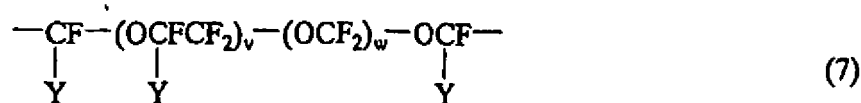
wherein A is as described above, and i and j are independently an integer of 1 to 300,

a penetration of a cured product of the gel composition according to JIS K2220 or ASTM D-1403 is in the range of 1 to 200.

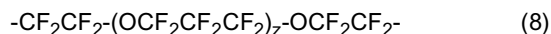
2. A curable perfluoropolyether gel composition according to claim 1 wherein the divalent perfluoropolyether structure-containing group comprising a structure selected from the group consisting of the units represented by the following formulae (6) to (8):



wherein Y is fluorine atom or trifluoromethyl group, p, q, and r are independently an integer of p ≥ 0, q ≥ 0, 0 ≤ p+q ≤ 200, and 0 ≤ r ≤ 6 excluding the case of p = q = r = 0;

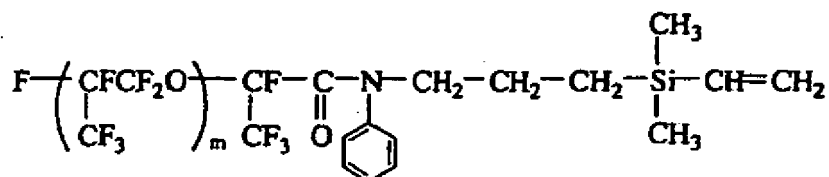
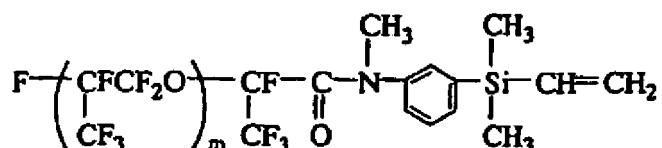
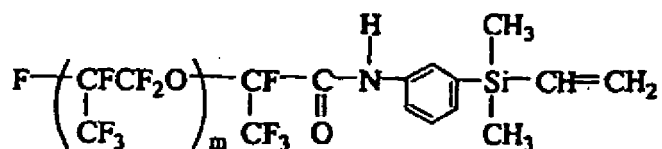
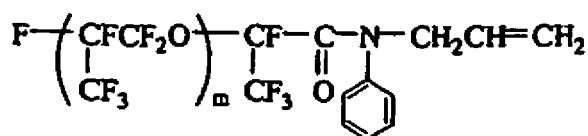
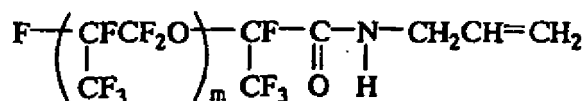
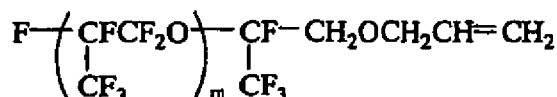
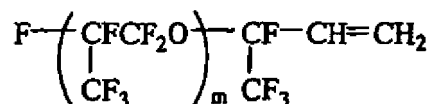


wherein Y is fluorine atom or trifluoromethyl group, and v and w are independently an integer of 1 ≤ v ≤ 20; and 1 ≤ w ≤ 20; and



wherein z is an integer of $1 \leq z \leq 100$.

3. A curable perfluoropolyether gel composition according to claim 1 or 2 wherein the perfluoromonalkenyl compound is one selected from the group consisting of the following compounds:



wherein m = 1 to 100.

4. A curable perfluoropolyether gel composition according to any one of claims 1 to 3 wherein an amount of a cured product of the gel composition remaining in solid state after immersing in conc. sulfuric acid (98%) at 40°C for 1,000 hours is at least 90%.
5. A gel product containing a cured product of the curable perfluoropolyether gel composition of any one of claims 1 to 4.
6. A gel product according to claim 5 wherein the product is adapted for use in automobiles, chemical plants, ink jet

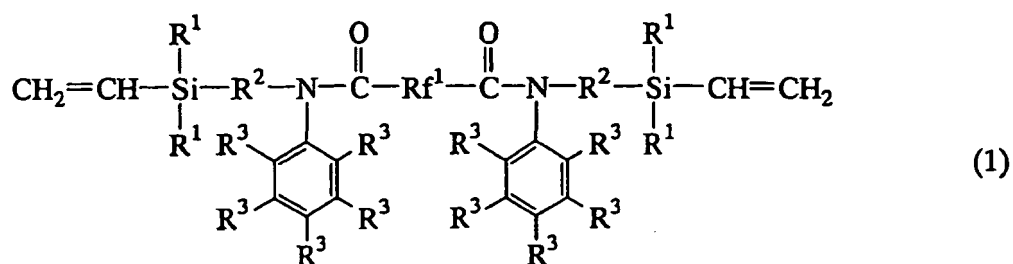
printers, semiconductor production lines, physical and chemical analysis equipment, medical equipment, aircrafts, or fuel cell production.

7. A curable perfluoropolyether gel composition of any one of the preceding claims which comprises 100 parts by weight of component (A), 1 to 300 parts by weight of component (B) in relation to 100 parts by weight of the component (A), 0.2 to 2 mol of the hydrosilyl group in the component (C) in relation to 1 mol of the alkenyl group of the components (A) and (B), 0.1 to 100 ppm of component (D) in terms of the platinum group in relation to 100 parts by weight of total amount of the components (A), (B), (C) and (E), and 0.1 to 150 parts by weight of component (E) in relation to 100 parts by weight of the total of components (A) and (B).
8. A curable perfluoropolyether gel composition of any one of the preceding claims which further comprises a regulator for the hydrosilylation.
9. A curable perfluoropolyether gel composition of any one of the preceding claims which further comprises an inorganic filler.

Patentansprüche

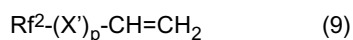
1. Härtbare Perfluoropolyether-Gelzusammensetzung, umfassend

(A) ein geradkettiges, fluorhaltiges Polymer mit mindestens zwei Alkenylgruppen pro Molekül, wiedergegeben durch die folgende Formel (1):



worin R^1 unabhängig Vinylgruppe oder eine 1 bis 4 Kohlenstoffatome enthaltende Alkylgruppe ist, R^2 eine 1 bis 6 Kohlenstoffatome enthaltende Alkylgruppe ist, R^3 unabhängig Wasserstoffatom oder eine 1 bis 4 Kohlenstoffatome enthaltende Alkylgruppe, wahlweise substituiert durch Fluor, ist und Rf^1 eine zweiwertige Perfluoropolyetherstruktur-enthaltende Gruppe ist,

(B) eine Polyfluormonoalkenylverbindung, die eine Alkenylgruppe pro Molekül enthält und in ihrem Grundgerüst eine Perfluoropolyetherstruktur aufweist und wiedergegeben wird durch die folgende Formel (9):

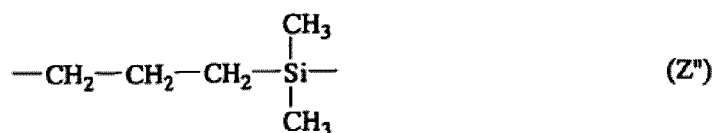


worin

X' $-\text{CH}_2-$, $-\text{OCH}_2-$, $-\text{CH}_2-\text{OCH}_2-$ oder $-\text{CO}-\text{NR}_4-\text{Y}'$ ist, worin Y' CH_2- , eine Gruppe (o-, m- oder p-Dimethylsilylphenylgruppe) ist, wiedergegeben durch die folgende Strukturformel (Z):

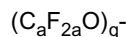


oder eine Gruppe, wiedergegeben durch die folgende Strukturformel (Z''):



R⁴ Wasserstoffatom, Methylgruppe, Phenylgruppe oder Allylgruppe ist;

Rf² eine einwertige Perfluorpolyetherstruktur-enthaltende Gruppe ist, welche die durch die folgende Formel wiedergegebene Gruppe ist:

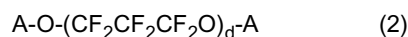


worin a eine ganze Zahl von 1 bis 6 ist, und q eine ganze Zahl von 20 bis 600 ist, und p 1 ist,

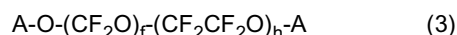
(C) eine Organosiliciumverbindung, enthaltend mindestens zwei Wasserstoffatome, gebunden an das Siliciumatom, pro Molekül,

(D) einen Hydrosilylierungskatalysator,

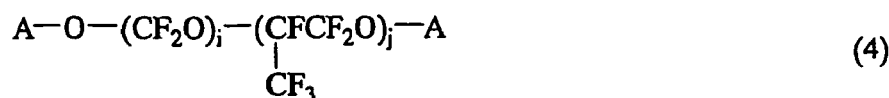
(E) mindestens eine Perfluorpolyetherverbindung, gewählt aus der Gruppe, bestehend aus den Verbindungen, wiedergegeben durch die folgenden allgemeinen Formeln (2) bis (4):



worin A eine durch die Formel: C_eF_{2e+1} wiedergegebene Gruppe ist, worin e eine ganze Zahl von 1 bis 3 ist und d eine ganze Zahl von 1 bis 500 ist;

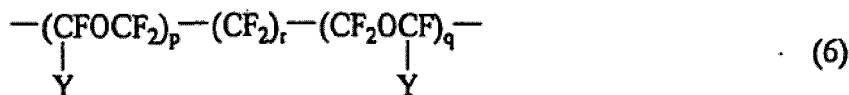


worin A wie oben beschrieben ist, und f und h unabhängig voneinander eine ganze Zahl von 1 bis 300 sind, und

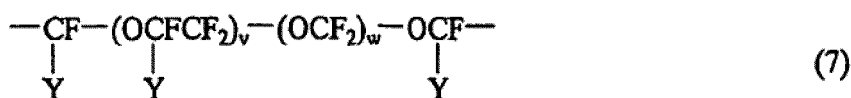


worin A wie oben beschrieben ist, und i und j unabhängig voneinander eine ganze Zahl von 1 bis 300 sind wobei eine Penetration eines gehärteten Produkts der Gelzusammensetzung gemäß JIS K2220 oder ASTM D-1403 im Bereich von 1 bis 200 liegt.

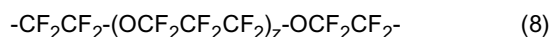
2. Härtbare Perfluorpolyether-Gelzusammensetzung nach Anspruch 1, wobei die zweiwertige Perfluorpolyetherstruktur-enthaltende Gruppe eine Struktur umfasst, gewählt aus der Gruppe, bestehend aus den durch die folgenden Formeln (6) bis (8) wiedergegebenen Einheiten:



worin Y ein Fluoratom oder Trifluormethylgruppe ist, p, q und r unabhängig voneinander eine ganze Zahl von p ≥ 0, q ≥ 0, 0 ≤ p+q ≤ 200, und 0 ≤ r ≤ 6, ausgenommen den Fall von p = q = r = 0;

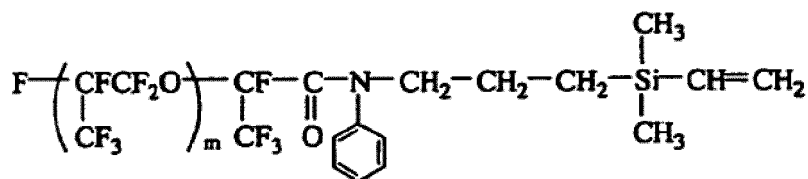
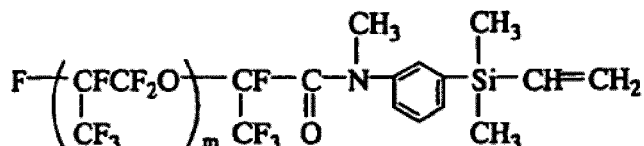
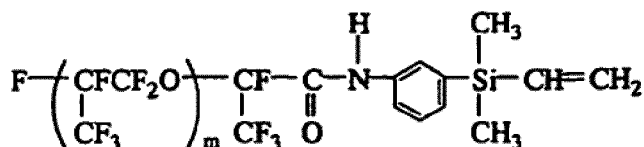
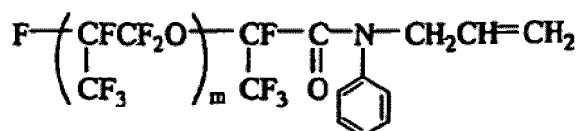
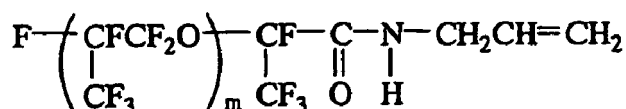
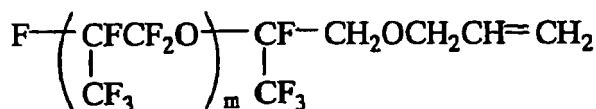
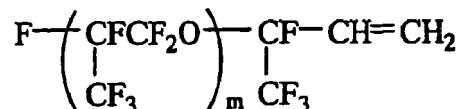


worin Y ein Fluoratom oder Trifluormethylgruppe ist, und v und w unabhängig voneinander eine ganze Zahl von 1 ≤ v ≤ 20; und 1 ≤ w ≤ 20; und



worin z eine ganze Zahl von $1 \leq z \leq 100$.

3. Härtbare Perfluorpolyether-Gelzusammensetzung nach Anspruch 1 oder 2, wobei die Perfluormonoalkenylverbindung eine ist, gewählt aus der Gruppe, bestehend aus den folgenden Verbindungen:



worin $m = 1$ bis 100.

4. Härtbare Perfluorpolyether-Gelzusammensetzung nach mindestens einem der Ansprüche 1 bis 3, wobei eine Menge eines gehärteten Produkts der Gelzusammensetzung, welche in festem Zustand verbleibt, nach Eintauchen in konzentrierte Schwefelsäure (98%) bei 40°C während 1.000 Stunden, mindestens 90% beträgt.
5. Gelprodukt, enthaltend ein gehärtetes Produkt der härtbaren Perfluorpolyether-Gelzusammensetzung gemäß mindestens einem der Ansprüche 1 bis 4.
6. Gelprodukt nach Anspruch 5, wobei das Produkt angepasst ist zur Verwendung in Automobilen, chemischen Anlagen, Tintenstrahldruckern, Halbleiterproduktionslinien, physikalischer und chemischer Analyseausrüstung, medi-

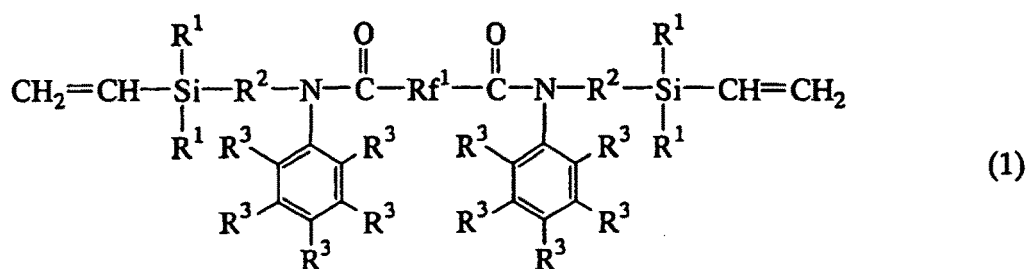
zinischer Ausrüstung, Flugzeugen oder Brennstoffzellenproduktion.

7. Härtbare Perfluoropolyether-Gelzusammensetzung nach mindestens einem der vorangehenden Ansprüche, umfassend 100 Gewichtsteile Komponente (A), 1 bis 300 Gewichtsteile Komponente (B) in Bezug auf 100 Gewichtsteile der Komponente (A), 0,2 bis 2 Mol der Hydrosilylgruppe in der Komponente (C) in Bezug auf 1 Mol der Alkenylgruppe der Komponenten (A) und (B), 0,1 bis 100 ppm Komponente (D) hinsichtlich der Platingruppe in Bezug auf 100 Gewichtsteile der Gesamtmenge der Komponenten (A), (B), (C) und (E), und 0,1 bis 150 Gewichtsteile Komponente (E) in Bezug auf 100 Gewichtsteile der Gesamtmenge der Komponenten (A) und (B).
8. Härtbare Perfluoropolyether-Gelzusammensetzung nach mindestens einem der vorangehenden Ansprüche, welche weiterhin einen Regulator für die Hydrosilylierung umfasst.
9. Härtbare Perfluoropolyether-Gelzusammensetzung nach mindestens einem der vorangehenden Ansprüche, welche weiterhin einen anorganischen Füllstoff umfasst.

Revendications

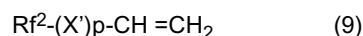
1. Composition de gel de perfluoropolyéther durcissable comprenant

(A) un polymère à chaîne droite contenant du fluor ayant au moins deux groupes alcényle par molécule, représenté par la formule suivante (1):



dans laquelle R^1 est indépendamment un groupe vinyle ou un groupe alkyle contenant de 1 à 4 atomes de carbone, R^2 est un groupe alkylène contenant de 1 à 6 atomes de carbone, R^3 est indépendamment un atome d'hydrogène ou un groupe alkyle contenant de 1 à 4 atomes de carbone éventuellement substitué par du fluor, et Rf^1 est un groupe contenant une structure de perfluoropolyéther divalent,

(B) un composé de polyfluoromonoalcényle contenant un groupe alcényle par molécule et ayant une structure de perfluoropolyéther dans son squelette, et représenté par la formule (9) suivante :

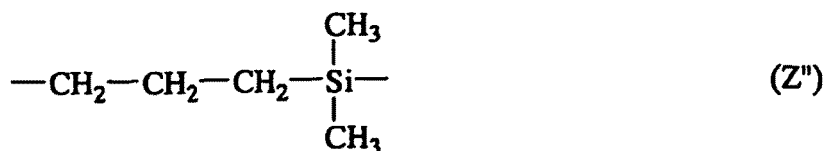


dans laquelle

X' représente $-\text{CH}_2-$, $-\text{OCH}_3$, $-\text{CH}_2\text{OCH}_2-$, ou $-\text{CO}-\text{NR}^4-\text{Y}'-$ dans laquelle Y' représente CH_2 , un groupe (groupe o-, m-, p-diméthylsilylphenonylène) représenté par la formule structurale (Z') suivante :

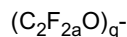


ou un groupe représenté par la formule structurale (Z'') suivante :



R⁴ est un atome d'hydrogène, un groupe méthyle, un groupe phényle, ou un groupe allyle ;

Rf² est un groupe contenant une structure de perfluoropolyéther monovalent qui est un groupe représenté par la formule suivante :

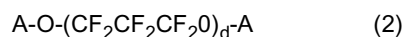


dans laquelle a est un nombre entier de 1 à 6, et q est un nombre entier de 20 à 600, et p est 1,

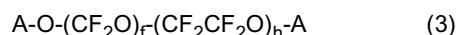
(C) un composé organosilicié contenant au moins deux atomes d'hydrogène liés à l'atome de silicium par molécule,

(D) un catalyseur d'hydrosilylation,

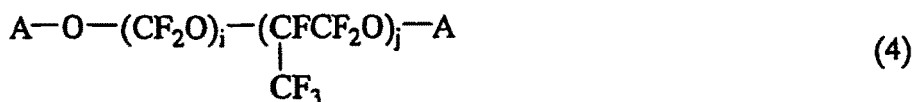
(E) au moins un composé de perfluoropolyéther choisi parmi le groupe constitué par les composés représentés par les formules générales (2) à (4) suivantes :



dans laquelle A est un groupe représenté par la formule : C_eF_{2e+1} dans laquelle e est un nombre entier de 1 à 3, et d est un nombre entier de 1 à 500 ;



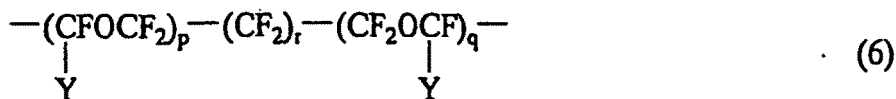
dans laquelle A est tel que décrit ci-haut, et f et h sont indépendamment un nombre entier de 1 à 300, et



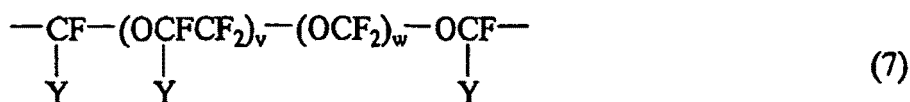
dans laquelle A est tel que décrit ci-haut, et i et j sont indépendamment un nombre entier de 1 à 300,

un taux de pénétration d'un produit durci de la composition de gel selon JIS K2220 ou ASTM D-1403 est dans la plage de 1 à 200.

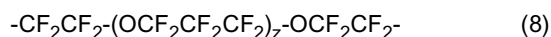
2. Une composition de gel de perfluoropolyéther durcissable selon la revendication 1, dans laquelle le groupe contenant une structure de perfluoropolyéther divalent comprend une structure sélectionnée parmi le groupe constitué des unités représentés par les formules (6) à (8) suivantes :



dans laquelle Y représente un atome de fluor ou un groupe trifluorométhyle, p, q, et r sont indépendamment un nombre entier de p ≥ 0, q ≥ 0, 0 ≤ p + q ≤ 200, et 0 ≤ r ≤ 6 excluant le cas de p = q = r = 0 ;

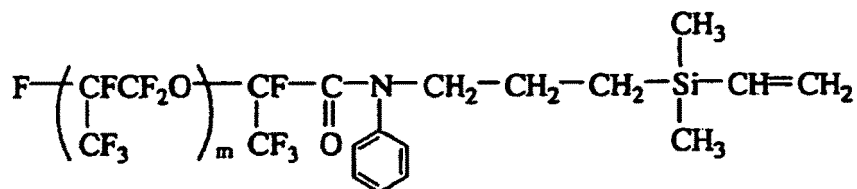
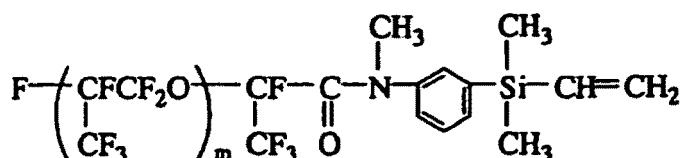
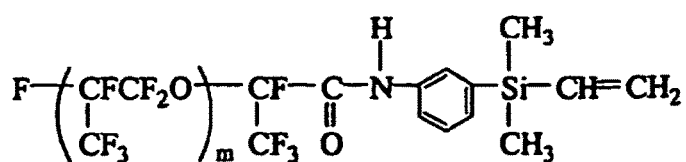
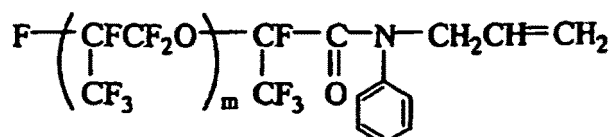
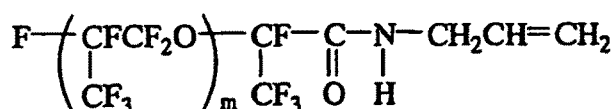
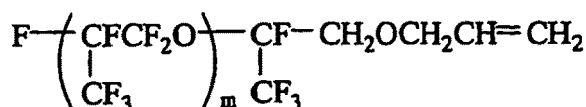
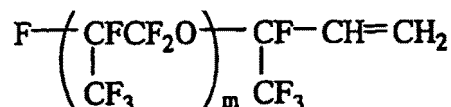


dans laquelle Y représente un atome de Fluor ou un groupe trifluorométhyle, et v et w sont indépendamment un nombre entier de 1 ≤ v ≤ 20, et 1 ≤ w ≤ 20; et



dans laquelle z représente un nombre entier de $1 \leq z \leq 100$.

3. Une composition de gel de perfluoropolyéther durcissable selon la revendication 1 ou 2, dans laquelle le composé de polyfluoromonoalcényle est l'un choisi parmi le groupe constitué par les composés suivants :



dans lequel m = 1 à 100.

4. Une composition de gel de perfluoropolyéther durcissable selon l'une quelconque des revendications 1 à 3, dans laquelle une quantité d'un produit durci de la composition de gel restant à l'état solide après immersion dans de l'acide sulfurique concentrée (98%) à 40 °C pendant 1.000 heures est d'au moins 90%.
5. Un produit de gel contenant un produit durci de la composition de gel de perfluoropolyéther durcissable selon l'une quelconque des revendications 1 à 4.

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6. Un produit de gel selon la revendication 5, dans lequel le produit est adapté pour être utilisé dans les automobiles, les usines chimiques, les imprimantes à jet d'encre, des lignes de production de semi-conducteurs, l'équipement d'analyse physique et chimique, l'équipement médical, des avions, ou la production de piles à combustible.

7. Une composition de gel de perfluoropolyéther durcissable selon l'une quelconque des revendications précédentes qui comprend 100 parties en poids du composant (A), 1 à 300 parties en poids du composant (B), par rapport à 100 parties en poids du composant (A), 0,2 à 2 mol du groupe hydrosilyle dans le composant (C) par rapport à 1 mol du groupe alcényle des composants (A) et (B), 0,1 à 100 ppm du composant (D) en termes du groupe de platine par rapport à 100 parties en poids de la quantité totale des composants (A), (B), (C) et (E), et 0,1 à 150 parties en poids du composant (E) par rapport a 100 parties en poids de l'ensemble des composants (A) et (B).

8. Une composition de gel de perfluoropolyéther durcissable selon l'une quelconque des revendications précédentes qui comprend en outre un régulateur pour l'hydrosilylation.

9. Une composition de gel de perfluoropolyéther durcissable selon l'une quelconque des revendications précédentes qui comprend en outre une charge inorganique.

REFERENCES CITED IN THE DESCRIPTION

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- JP 2000248166 A [0006] [0034]